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CONTENTS.

EDITORIAL: PAGE.

Paragraphs ... 65

ILLUSTRATED ARTICLES:

A Simple Electric Meter ... 66
Electricity on the Steamer "Connecticut" ... 66
A Domestic Motor Pump ... 68
The Ongley Electric Elevator Valve ... 68
An Extraordinary Dynamo ... 68
Some Convenient Fuse Terminals ... 69
Electric Plant in a New York Church ... 69
A Street Railway Pole-Top ... 70
Electrical Distribution by Transformers ... 73
Wooden-Toothed Gearing for Street-Car Motors ... 74
A Marine Lighting Plant for the "Vesuvius" ... 75
The Law of Economy in Electrical Conductors ... 75

MISCELLANEOUS:

New Books ... 66
The Western Union Fire ... 68
A British Co-operative Electric Light Station ... 69
The Modling-Hinterland Electric Railway ... 70
Legislation in Massachusetts ... 70
The Lake Superior Mining Region ... 71
Sparks from Belts ... 72
The Cape May Meeting ... 76

SPECIAL CORRESPONDENCE:

New York Notes ... 77
New England Notes ... 77
Philadelphia Notes ... 77
Western Notes ... 78
Southern Notes ... 78
English Notes ... 78

NEWS OF THE WEEK:

The Telegraph ... 78
The Telephone ... 79
The Electric Light ... 79
Applications of Power ... 79
Miscellaneous ... 79
Personal ... 79

INDUSTRIAL AND TRADE NOTES ... 80
ANSWERS TO CORRESPONDENTS ... 80
BUSINESS NOTICES ... 80

An Unjustifiable Attack.

WE regret to see that our very esteemed contemporary, the *New York Herald*, has gone out of its way, in its editorial columns, to attack the Edison phonograph by speaking of it as a well-advertised toy. Our readers are so well aware of the absurdity of this statement that we need hardly contradict it in our columns; but if the editors of the *Herald* are still in darkness on the matter, we should be glad to have one or all of them (we understand that their number is legion) call upon us some afternoon and see our business manager using this "toy" as a means of disposing of his letters at the rate of between fifty and sixty per hour. We feel sure that if they could see the business usefulness of this "toy" as employed by us, they would be moved to restrict their editorial remarks in the future to matters upon which hey are better informed.

Professor Thomson's Dynamo.

IT is something of a revolution to find a dynamo without external magnetic field and without commutator or sliding contacts of any kind, in fact we know but two such, and those little used. Yet it is just this that Prof. Thomson's ingenuity has given us; and, to judge from the details of its construction, so far made public and given in another column, the new machine possesses many valuable properties. The air space in the magnetic circuit may at first sight seem large, yet it can be reduced to an amount far below that found in most ordinary machines, for as the revolving portion carries no wire the clearance space may be reduced to the smallest amount that is mechanically safe. Thus the requisite magnetism may be secured quite cheaply. The small amount of hysteresis and complete freedom from sparking are also marked advantages, and altogether the machine seems to embody many new and admirable features. We shall await with keen interest reports concerning its efficiency and practical operation.

Co-operative Lighting.

WE give elsewhere a description of a new co-operative central station recently established in England. Domestic electric lighting is so desirable that it really is a wonder that more of it is not done. There are few householders who would not exchange gas and kerosene for the beautiful glow lamp if they could do so without incurring heavy expense. Already numerous country houses are equipped with miniature plants, but the trouble and expense is necessarily rather a drawback. Of course, where central stations are within reach the problem solves itself; but there are many localities far from any source of supply or in suburbs inaccessible because of regulations against overhead wires. In such places the co-operative plan has much to commend it, and a group of houses could be lighted with comparatively small outlay. It would be interesting to know just what can be accomplished by this means in the way of economy, and we hope to hear encouraging reports of successful operation ere long.

Electricity in Mines.

THE paper by Mr. De Land on the applications of electricity in the Lake Superior mining region is a striking record of rapid progress and triumph over new and formidable difficulties. The mere question of available protection for the lighting mains is one that required for its solution long and costly practical experimenting—which, however, paid royally in the excellent results obtained. The question of safety aside, the added facilities for effective working afforded by the electric light tend most directly to increase the output and hence the profits of a mine. The introduction of electrical mining machinery would certainly accomplish even more in the way of immediate benefit, and the time is fast approaching when the amount of severe manual labor required in mining operations will be enormously reduced. The whole Lake Superior region seems to be keenly alive to the direct advantages of electric light and power and to be making most rapid progress. It is most encouraging to see the spirit of enterprise among the mine owners in that peculiarly favored region, and to note the engineering skill that has made possible such complete success and such rapid growth of electrical industry.

Electrical Meters.

PROF. THOMSON'S very ingenious pendulum meter calls to mind the progress that metering electricity has made in the last few years. The alternating current, with its wide range of distribution and consequent ability to do much lighting in private houses, has emphasized the call for meters that was already heard in the very beginning of electric lighting, and had already been met for the continuous current by the Edison electrolytic apparatus. To-day the tendency is very strong toward basing charges on current actually consumed, and the amount of inventive skill that has been called into play is marvellous. It might appear from this that excellence is particularly hard to attain, but it is safe to say that there are now several meters on the market that are every bit as accurate and convenient as gas meters. This may sound like faint praise, but it is really saying considerable, for the much-abused instrument just referred to is generally exact to within one or two per cent., public opinion to the contrary notwithstanding. The growing use of the electric meter acts rather favorably on electric lighting, for the user feels that he knows what he is paying for, and the business is brought down to a definite sort of commercial transaction that will in the long run benefit both parties.

"Let Us Alone."

THE tendency of the modern legislator to meddle with everything he can lay his hands on is strikingly shown by the list given in part elsewhere in our columns of the bills that were introduced in the Massachussetts Legislature during the past session. Electricians are just beginning to feel the effect of this meddlesomeness, which has proved so embarrassing to other industries that many States have been obliged seriously to curtail the powers originally "reserved to the States" and reposed in their legislatures, and our Massachussetts brethren are to be congratulated upon the success of the efforts made by them to prevent the enactment of any severely hostile legislation. In some localities there has not been such good fortune; and for a few years to come, that is to say until the public is educated up to the point of feeling that electricity is a household necessity, it will be advisable to keep a watchful eye upon the law-making bodies during their annual or biennial sessions. Especially is this true with regard to enactments suggested by the unreasonable fear that has permeated the public mind as to the danger of overhead wires. While strict supervision is probably best for all concerned, and has been favored by the counsel of the Massachussetts companies, it should not be forgotten that police regulations can do little good in the long run, and may do irreparable damage to large interests.

Mr. Atkinson's Views.

THIS, indeed, is the fundamental secret of the enormous success in another direction that has attended the New England Mutuals, whose president has written so valuable a letter in regard to the recent fire in the Western Union building in this city. Mr. Atkinson's experience—and no one in this country has a wider—leads him to believe that other measures than building laws and the like are necessary for the preservation of property from the dangers of fire; concretely, these measures, says he, must be derived from and guided by a healthy self-interest. In no other way than the education of owners and builders as to their own good could such marvellously low percentages of loss as those he reports be achieved. That this is especially true in matters electrical is evidenced by his statement that his company, representing over $500,000,000 of mill capital, has never suffered a loss of any kind from electrical currents other than lightning. Such a statement simply marks the goal toward which all other electrical engineers should strive—that of the absolute safety of their installations. It is a goal that can be reached, for it has been reached by others. *Apropos*, we are glad to hear that our suggestion as to the rebuilding of the Western Union structure has not fallen upon deaf ears, and that everything possible will be done to eliminate inflammable material in the new structure. When the telegraphic facilities of half a continent are at stake, no amount of care is excessive, no precautions are unnecessary.

The Navigator's Friend.

WE show in this issue a group of ingenious appliances that ought to be of great interest to those of our readers who have occasion to travel by boat. Navigation on crowded waters like Long Island Sound requires extraordinary caution in bad weather, and anything that tends toward safety should meet with a warm welcome. Perhaps the most useful part of the apparatus we show is the search light itself. "Search light" is in this connection, however, rather a misnomer; "signal light" would be more appropriate. For the "Connecticut" has no hostile torpedo boats to hunt out of the darkness and bring under fire, but has to dread a foe more constantly present and scarcely less deadly, the sharp prow of another vessel unseen through the fog until it looms up close at hand and cuts a deadly gash in the unarmored hull. For defense against this danger the search light is no longer devoted to a vain attempt to pierce the surrounding fog, but is turned straight upward; rising skyward a luminous pillar above the vessel's prow, it marks her position so clearly that none need cross her path. Other useful devices are the automatic flashing mechanism, and the electro-magnetic whistle sounder, all under perfect control from the pilot house. In inland waters, where the chief danger is a collision in darkness and fog, the usefulness of such safety appliances can scarcely be over-estimated, and the added sense of security given the passengers has a very real value to those who take such precautions.

A Chance for Improvement.

WE sincerely wish that at the coming meeting of the National Electric Light Association something could be done toward a definite classification of electric lights, arc and incandescent. As it is we have a purely conventional nomenclature based on alleged candle power. Electricity is now beyond the stage where it needs to take refuge behind plausible names, and it is high time that we should all come down to straightforward terms and say what we mean. For some time engine builders listed their machines by horse powers. It did not take long, however, for the public to understand that such a rating was very misleading unless more details were given, so that to-day the conventional horse-power is specified as pertaining to a standard cut-off and boiler pressure. Many makers go further than this and do not attempt to assign a nominal horse-power at all. A similar reform is much needed in electric lighting. If it is best for example to speak of 16 c. p. lamp, let it be specified that the intensity of the light shall be based on the maximum, or mean horizontal, or mean spherical, or some other one of the many different "candle powers" possible. Such a distinction is even more necessary in the case of the arc lamp, where the variations of intensity are far wider. A better arrangement would be to classify all electric lights by the watts consumed, for this quantity is susceptible of easy measurement and is fast growing to be the basis of payments in incandescent lighting. The alleged 16 c. p. lamp is approximately a 50 watt lamp, just as the so-called 2,000 c. p. arc is a 500 watt lamp, and, although such a classification is a somewhat radical departure, it is at least consistent, easily verified and convenient.

NEW BOOKS.

Congres International des Electriciens, Paris, 1889, Comptes Rendus des Travaux publiés par les soins de M. J. Joubert, Rapporteur-General. Paris, Gauthier-Villars et Fils. Pp. 388.

Such a volume as the one before us has little need of commendation, for the large amount of valuable matter presented at the memorable congress of last year is not unknown to the technical public and was discussed in The Electrical World at the time. The present report, prepared by the careful hands of M. Joubert, contains in excellent form the record of the transactions and the valuable papers that were read. It is hard among so many contributions to electrical knowledge to call special attention to any one investigation. The transactions of the congress so far as they relate to the electrical world at large are already well known, but in the discussions reported will be found a large amount of instructive matter bearing on a wide diversity of subjects that is well worth careful reading. It oftens happens that the comments on a paper read before a scientific body are equally important with the contribution itself, and at this congress the large number of distinguished electricians together made the comments of peculiar interest and value.

Electricity for Engineers, by Charles Desmond; pp. 255, 77 illustrations; Chicago, The Engineer's Company, 1890. $1.00.

It is no easy task to write a technical book that shall give untechnical readers a clear idea of the subject discussed. Specially it is difficult to put the rationale of complicated electrical processes in simple language without serving up electrical food for babes that leaves the electrician disgusted and the novice befuddled. The author of the work in hand has avoided the mistakes of so many of his predecessors, and has produced what is really a very practical book for practical men—a book that can be easily read by the average engineer, and can not fail to give him very clear ideas about the operation and care of the electrical machinery that is entrusted to his supervision.

Of course we should not advise engineers—a class generally of more than ordinary intelligence—to confine themselves to books as exclusively practical as this, which will, however, serve admirably as a beginning. The dynamo can be explained as a machine and operated as a machine with a considerable degree of success; but eventually the evil day comes when the dynamo tender discovers that it is a rather delicate electrical instrument, only to be cared for by one who has some distinct knowledge of electrical principles.

The present book appears to be specially rich in the little practical points that are generally learned only by experience, and ought to fend off very many accidents. Nothing, for instance, can be truer or more to the point than the author's remark that trouble with a dynamo is directly in proportion to the time that is allowed to elapse between the first bad indication and the remedy. In fact this whole chapter on commutators and brushes will repay very careful reading. It would have been well, however, to call attention to the wide difference between arc and incandescent machines in the matter of sparking.

The engineer accustomed to the former will often allow severe sparking to occur on the latter, not realizing that the long, bluish-white, venomous-looking spark of the arc dynamo does little harm compared with the small, often greenish spark on the narrow commutator segments of an incandescent machine. The quantity is so much greater in the latter case that with apparently equal sparking far greater damage will be done.

The detailed description of the regulating devices employed on various dynamos is likely to be of great service, as in many cases serious trouble comes from ignorance of the operation and proper adjustment of this small but all-important part of a lighting system.

Mr. Desmond, however, does not devote enough space to the incandescent dynamos, and unfortunately omits alternating apparatus altogether. It seems to us that this omission is serious, and should be supplied in a second little volume. In some respects alternating apparatus is much easier to care for, but it has its own peculiar difficulties, and needs and deserves a special treatment.

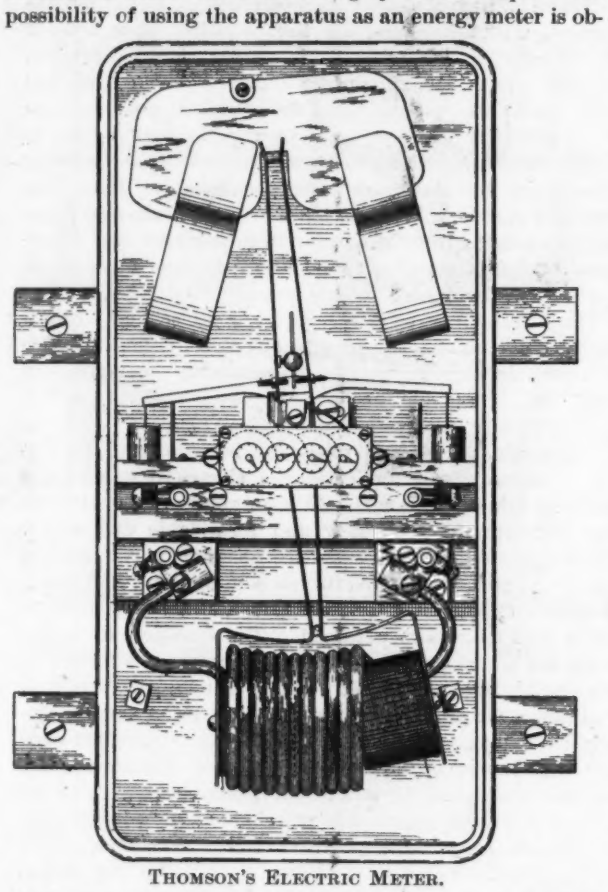
The chapters on testing are excellent, and should enable the reader to use the ordinary forms of testing apparatus readily and intelligently. On the whole, Mr. Desmond is to be congratulated on having written a book that will be of considerable service in giving the engineer a distinct idea of the electrical machinery with which he has to deal.

A Simple Electric Meter.

A very ingenious application of Professor Thomson's beautiful experiments in electro-magnetic repulsion by alternating current is to be found in his electric meter, of which a cut is given herewith. It is an exceedingly simple contrivance, and is as effective practically as it is neat theoretically.

This meter is a modified form of the motor type that measures the current by its direct electro dynamic action, but as will be seen, possesses some rather interesting peculiarities. Like most similar devices, it registers the readings directly upon dials like a gasmeter, and can consequently be read by the consumer at any time. This is no small convenience, although perhaps somewhat overestimated, for it is no guarantee of accuracy.

The arrangement consists, as shown, of a single coil of coarse wire wound along a gentle arc. This carries the main current to be measured. Immediately above it is a pendulum, mounted on knife edges, and provided at its lower edges with a pair of coils of fine wire, which are swung inside the solenoid just mentioned. The pendulum is prolonged above the knife edges, and bears at its upper extremity a light copper sheet, which swings in the magnetic field produced by the permanent magnets shown. This delicately-poised pendulum is provided with the apparatus intended for registering its oscillations on the dials. The motive power is the repulsive force produced by the solenoid on the two fine coils of the pendulum. These are alternately connected as high resistance shunts across the mains of supply. The main current is thus forced through the actuating solenoid, while a derived current of small quantity energizes alternately the two coils on the pendulum bob, being shifted from one to the other at the extremity of the swing by means of the commutator attached near the knife edges of the pendulum. Thus when current is turned on the meter a steady air line is set up, damped considerably by the currents induced in the copper sheet at the upper extremity of the pendulum and checked at either end of the swing by elastic stops. The possibility of using the apparatus as an energy meter is obvious, and altogether it seems a very finished and simple apparatus for registering the amount of current passing through. It is obvious enough that slight modifications will enable it to be used for measuring continuous currents also.



Thomson's Electric Meter.

Electricity on Long Island Sound Steamers.

Few of the thousands of people that annually travel between New York and Boston upon the palaces that ply the waters of Long Island Sound have the slightest conception of the number and variety of the devices that are used for increasing their comfort and making certain their safety during the hours of darkness that they pass on the way to or from Providence and Newport. Every one, of course, has seen descriptions of the modern steamship and steamboat, and all Americans have a general impression that upon our rivers and bays are to be found the most perfect types of inland craft that are to be seen anywhere in the world; but as to the inventive genius and untiring energy that has created these extraordinary craft not one in a hundred has any adequate conception. It is in the minor details that the great steamboat of to-day excels those of one, two or three decades ago.

In the development of the modern steamboat electricity bids fair to play a very large part, and the illustrations which are shown on the opposite page will give the layman, and even the electrician, some astonishment as showing the very large number of uses which are fulfilled by the electric current in the production of safety and comfort and beauty on the steamers of the Providence line, running between New York and Providence and New York and New London.

First and most important of the modern appliances of electricity at sea is unquestionably the search light. That adopted by the Providence line is the Huntington search light, manufactured by the Scott Electric Company, of 26 Liberty Street, New York, details of which are shown in our Figs. 1, 2 and 8. Fig. 1 shows the search light as placed on top of the pilot-house of the steamer "Connecticut," with the directing wheel underneath and the pilot standing with his hand ready to throw the light upon any object within range of vision, near or far. Fig. 2 shows the general appearance of the interior of the light, with the weight by which is accomplished the maintenance of the arc between the two carbons, whether the light be in a horizontal, vertical or diagonal position. This unusual feature of the Huntington search light seems to us of very great importance, as it makes it possible upon foggy nights to throw a beam of light directly upward and to continue such beam in that position as long as is desired by the pilot. The use of the light in this manner is shown in Fig. 3, and the reason for its value, as given by naval officers and others of long experience, is that a light thrown upward is visible in ordinary low-lying fogs to a much greater distance than a light thrown horizontally toward the object which it is desired to warn of the presence of the boat. The reason for this seems to be, at least on the waters of Long Island Sound, that the fogs there prevailing are, as a rule, not more than 200 feet in height, and that the light once having penetrated this layer reaches the clear above, its glow being there thrown to an indefinite distance and seen by other vessels, themselves enveloped in fog, at a much greater distance than any light could be seen that was at or near the surface of the water.

The search light is regulated by push buttons in the pilot-house and may be turned on or off at the will of the pilot, but in practice it is mainly used for flashing the perpendicular light simultaneously with the blowing of the fog whistle—that is to say, for a space of about six seconds once every forty seconds. The steamer "Connecticut" carries, in addition to the Huntington search light, a Macintosh automatic electric steam whistle, shown in Fig. 4 of our illustration, and the two are synchronously regulated by means of the very ingenious device shown in Fig. 6. In this the cam, revolving once every 46 seconds, automatically flashes the search light and blows the whistle simultaneously. The Macintosh device is simply a magnetic coil in which is suspended by a spring a bar of iron. When the current is supplied to the magnet the iron bar rises and opens the valve of the whistle. The whole thing is extremely simple and yet extremely valuable to the pilot, making certain that his whistles are blown and his flash given at exactly the periods recommended by the naval boards, which periods may, however, be varied at the will of the engineer when so instructed by the pilot. The whole mechanism, as we have stated, is controlled from the pilot-house, and if it should so happen that during one of the six-second automatic blasts the pilot desired to stop either the whistle or the light or both, he can do so without leaving his post and without any further trouble than the touching of a button.

Fig. 8 gives in greater detail the mechanism of the Huntington search light, showing the magnet, the ratchets, regulators, etc. The whole is perfectly simple and at the same time very serviceable and certain in its operation. The power for this light is supplied from the two United States dynamos shown in Fig. 7 that light the remainder of the boat, each of which is of 400-light capacity. Of course, those who have traveled on vessels supplied with electric lights need not be told that in the cabins and staterooms of the "Connecticut" everything possible has been done to make the incandescent lights as attractive and artistic as possible. In Fig. 5 is shown a view of the main cabin, giving the positions of the lights and their general effect.

To return to the pilothouse, only those who have seen the work required safely to conduct a boat of this kind through the tortuous passages leading into New York harbor from the East can have any idea of the importance of every little detail that improves the capacity of the pilots to see and know and feel their accurate course. One of the first requisites in a pilot-house after dark is the absolute exclusion of light, in order that the eyesight of the captain and pilots may be unaffected and may remain sufficiently clear to distinguish objects at a distance; and yet it is necessary occasionally to see something in the pilot-house itself—the clock must be consulted, for example, or the slate log must receive an entry, and in such little details as these the incandescent lamp achieves absolute perfection. In the pilot-house of the "Connecticut" the captain, still remaining at his post, may touch a button and throw a light upon a clock at his rear, 20 feet away, and yet not illuminate anything in or out of the cabin except the face of that clock. In the same way he has at his hand a hooded incandescent lamp which he may turn on and direct at his slate or at any other object near at hand without interfering with the eyesight of any of those who are peering out into the darkness beyond.

Although not an electric device, another detail in this pilot-house strikingly shows the importance attached by navigators to the maintenance of darkness. Hanging to the ceiling of the room is a rope connected with the tiller carrying a small bulb covered with luminous paint; and affixed to the roof are three such bulbs about 2 feet apart. These bulbs are all visible in the darkness, and the position of the moving one as compared with those that are stationary keeps the steersman informed of the exact position of his rudder. The precaution is, of course, made necessary by the fact that the boat is steered by steam, so that the rudder does not return to center when the wheel is released.

The pilot-house of the "Connecticut," take it all in all, is beyond doubt a model in its way, and reflects great credit upon President Miller, of the Providence line, as well as upon Messrs. Deming, his secretary, and Scott and Brown, of the Scott Electric Company, each of whom has contributed a share to the perfection of its devices.

ELECTRICAL FEATURES OF THE LONG ISLAND SOUND STEAMER "CONNECTICUT."

The Western Union Fire.

Mr. Edward Atkinson, the most respected expert in regard to industrial fire insurance in America, has written an extended and valuable letter to the editor of the New York *Evening Post* concerning the recent fire in the Western Union building. Mr. Atkinson is the central spirit of the factory mutuals of New England, an organization known by the great success that has attended its system of rigid inspection and of insistance upon what is called "slow-burning construction" as distinguished from fireproof building. He begins by saying:

SIR: Referring to your recent article on the fire opposite your office, you may rightly credit me with having attempted to call the attention of owners, architects and underwriters to the principles of slow-burning construction and of adequate protection against destruction by fire. But permit me to call your attention to the fact that these principles and methods have been the slow growth of half a century of experience, which ought now to be a part of the common knowledge. It has been gained under the constant supervision, guidance and direction of my predecessors and coadjutors, who have been charged with the duties long before I came into the service of saving the textile factories, paper mills, machine shops and other works of like kind from destruction, and from the same hazards which now infest commercial warehouses, office buildings and the like. Only in the nature of the case our hazards are of a much graver kind than those which have so seriously interrupted the Western Union Telegraph Company by the destruction of the upper part of their building, which, according to the description, was in many elements a well-constructed building.

Mr. Atkinson has something to say in passing about the recent conflagration in Boston, which he evidently ascribes to bad building and not to electricity, and the manner in which he predicted even the details of that fire seem to us a marvelous exhibition of his knowledge of the subject:

In justification of the methods which have been adopted by the owners of factory property, now amounting to more than $500,000,000, in this combination, I may venture to state the fact that when the building in which the great fire in Boston on Thanksgiving Day, 1889, originated was in process of construction, several years before I was a member of the Committee on Information of the Boston Underwriters' Union, and although the company of which I am president would not have insured this building at any price which could be named, even had it been in the open country, I thought it to be my duty to the Union to send a memorial to the mayor, in order that the method of construction might be altered and made safe in any way it could be done under the Building Act then in force.

In that memorandum I indicated three sufficient but removable causes for the rapid and complete destruction of the building from a very small fire, if that fire were not extinguished in the first two or three minutes; I also laid down in that memorandum the probable course of the fire and the consequences of the rapid destruction of that building. I was summoned as a witness by the fire marshal, *after the fire*, to whom I presented a copy of this memorial to the mayor made at the time the building was in progress. The predicted incidents, course and consequences of the fire were so exactly in accordance with the facts which were disclosed after the fire that my *a priori* statement was substantially incorporated in the report of the fire marshal as an official description of what actually occurred.

Concerning the Western Union building, Mr. Atkinson is by no means a severe critic, and he has praise for the construction, mixed with criticism of its contents; but it is admitted that the insulating necessities of the case are a sufficient excuse on this head:

From what I have learned of the conditions of the Western Union building, it would appear that the shell of the building had been well devised for safety, but that a great deal of wood had been used in the finish where it was entirely out of place, and that the greater part of the furniture had been of a combustible sort, where it would have been far better and safer had it been of incombustible material.

The accounts of the fire speak of the spread upon the "switchboards," and from "table to table" on which instruments had been placed. The difficulty of choosing incombustible material on account of electric conductivity is admitted, yet there are very many materials which are perfectly suitable for such service that are not combustible or ignitable.

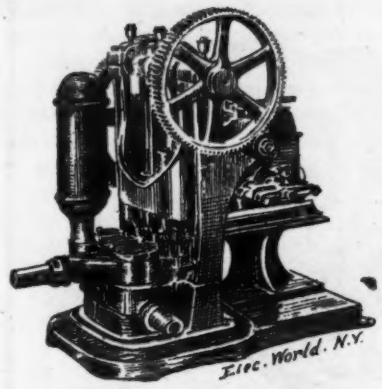
The private hose within the building is said to have been rotten, as it usually is when not under the care of a private fire department well trained in its use. The passage of fire from floor to floor was wholly unobstructed, a useless exposure in such a building in which the only open way should have been the elevator shaft, guarded by suitable fire doors and surmounted by thin glass so as to give easy vent to a fire on any floor. There were no roof hydrants or other appliance by which the building could have been flooded from above, and finally, there were no automatic sprinklers.

But the most interesting feature of Mr. Atkinson's letter is his statement that the Factory Mutuals, representing property capitalized at over five hundred millions of dollars, *has never suffered a loss of any kind from an electric wire*. After this statement from so eminent an authority, it will be as well for insurance men to cease their senseless talk about fires caused by electricity. The truth of the matter is that bad construction causes fires, whether it is applied to one part of a modern building or to another. Bad construction cannot wholly be avoided; but the bad construction of electric distributors can be wholly avoided, and when so avoided, as this experience proves, the risk of fire from this cause is reduced—note the figure—not to a low percentage, nor to "almost nothing," but to absolute zero. We quote Mr. Atkinson's exact language:

There are some admitted difficulties in placing automatic sprinklers for the protection of buildings to which high-tension electric currents are admitted, lest the water itself should make cross arcs on which the high-tension current of electricity might be spread. On this point we have as yet no experience, as all the electric apparatus in our risks has been so carefully put up and is so constantly guarded that *we have never met a loss from an electric current*, except those which are generated in the clouds during thunderstorms. There were no high-tension currents in this service in the Western Union building, if I am rightly informed; therefore an equipment with automatic sprinklers in the electric department would doubtless have saved the entire loss.

A Domestic Motor Pump.

The accompanying cut shows one of the neat little motor pumps that are coming into somewhat extensive use as the facilities for obtaining electrical power become more widely available. The pump itself is of the well-known Gould triplex type, and is connected by a double set of gearing



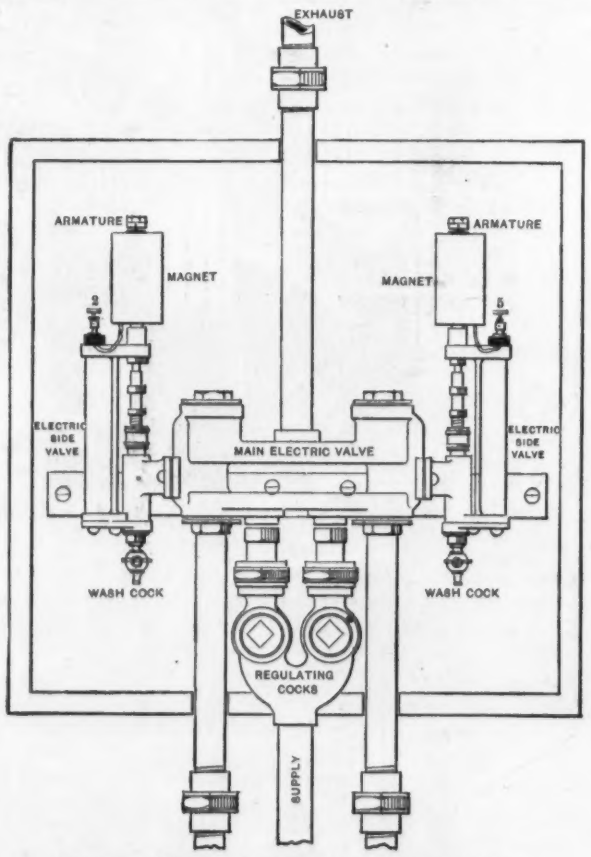
COMBINED MOTOR AND PUMP.

to a ½ h. p. Perret motor. This can be attached to an incandescent lighting main, or even, if desirable, run by a battery, if especially wound, as it can be for that purpose. The pump, it will be seen, is a very small one, having just about enough capacity for ordinary domestic service, about 100 gallons an hour, raised 50 feet high. The amount of power consumed is evidently small enough, about as much as a couple of 16 c. p. lamps, and consequently the expense of running is but slight. It is an exceedingly compact and available little power pump and should meet the requirements of light service admirably. Its action can be made entirely automatic by a tank float controlling the switch, so that it need not even be looked at or thought of, except at occasional intervals.

The Ongley Electric Valve as Applied to Elevators.

The application of electricity to the working of elevators has recently received considerable attention from those most interested in their safe, economical and satisfactory operation.

In THE ELECTRICAL WORLD of July 5 an elevator, the motive power of which was an Eickemeyer electric



ONGLEY VALVE—DIAGRAM OF CONNECTIONS.

motor was illustrated and described. Another method of utilizing electricity in elevator work is by the use of the ordinary hydraulic apparatus, the valves of which are controlled by suitably arranged electro-magnets which are operated from the elevator car. The accompanying illustration shows the Ongley electric valve, a mechanism of this kind, as applied to the ordinary lifting machinery of an elevator, in the Lancashire Insurance Building of this city.

This valve, invented by Dr. C. E. Ongley, has now been in successful operation for over two years in some of the principal elevators in this country. It can be applied at a small cost to any style of elevator and is said to be economical, effectual and entirely satisfactory. The valve is controlled from a button board placed in the car.

Upon this board are two ordinary push buttons, connected by three wires in a flexible cable to the electro-magnets of the electric valve which is placed below near the main elevator valve.

Our cut shows a diagram of the electric valve mechanism. If the upper button in the car is pressed the side valve which supplies water to the end of the piston is opened and this causes the car to ascend. Pushing the lower button operates the valve so as to cause the car to descend. When the car is ascending it is stopped by pushing the lower button, and if descending by pushing the upper one. The car can be run at any desired speed, as this is regulated by the length of time the button is held in contact.

This arrangement for controlling the running of the elevator makes it possible to use cut-outs placed upon each landing, so that when the door is opened the circuit to the button board is broken, and the car cannot be started until the door is closed. Another feature is the presence in the car of the usual controlling rope, which can at any time be used in connection with the electric valve if necessary, so that this valve, beside being an improvement, acts also as an extra safety device. The electric valve is so arranged that it cannot become locked in case of accident and interfere with the use of the rope control.

In private residences where no attendant is employed to operate the elevator, the button boards are placed outside of the shaft at each landing as well as in the car, using in this case three buttons. If the car is at the bottom of the shaft and it is desired to bring it to any floor above, the person at that floor presses the upper button and holds the centre one until the car reaches that particular floor and stops; then the door of the shaft can be opened, and there is no danger of any one on any other floor moving the car away, while another person is stepping into it, as might be the case with the old method of control. Nor can the car be moved until the door is closed. The person in the car can then, by means of the buttons in the car, move it in either direction, stopping automatically upon the desired floor.

The battery required to operate an elevator of any size is only 12 open circuit cells. If desired, power may be taken from an ordinary incandescent light circuit, a 16 c. p. lamp being put in series with the magnet coils to increase the resistance of the circuit. It has been ascertained in practice that more service can be obtained from an elevator by the use of this method of control, as the simple pushing of the button occupies so much less time than the pulling of a rope. The motion of the elevator is very smooth, as the starting and stopping are not so sudden and jerky as with some other methods of control, and the strain upon the elevator machinery is also lessened.

An Extraordinary Dynamo.

The accompanying cut shows the details of a dynamo electric machine so extraordinary in its structure and electrical properties as to be fairly revolutionary; a machine quite as unique in its way as the Duncan motor, to which reference was recently made in our editorial and other columns. The new machine is the invention of Prof. Elihu Thomson, and its special marked properties are total absence of external magnetic field and almost complete freedom from hysteresis.

Fig. 1 shows a section of the machine. The revolving portion of it consists of a shaft surrounded by a massive iron cylinder bearing on its central portion the laminated mass of iron that forms the internal pole pieces. The appearance of this part of the machine is shown by Fig. 3. This iron mass revolves within a pair of iron sleeves, which carry the bearings of the machine and the magnetizing coils, which are thus fixed and wound on bobbins on either side of the revolving poles. The end plates of these massive sleeves are joined by a cylindrical casing of iron completely shutting in the machine. On the interior of this casing, and immediately surrounding the revolving pole pieces, is a ring with inwardly pointing poles barely clearing the revolving ones. Looped around these poles are the armature coils. The magnetizing coils of the machine are so wound as to produce, in the revolving portion, consequent poles of the same polarity in each of the polar projections. The magnetic circuit extends through the internal cylinder and its surrounding sleeves through the outer casing, and forms consequent poles of opposite polarity to the revolving ones in the polar projections that point inward. There is thus no external field whatever.

The action of the machine is as follows: The moving field poles carried around by the revolution of the core piece pass in front of the coils in which the currents are to be induced. The lines of magnetic force from these pole pieces cut transversely across the wires on the coils, since these lie in the proper direction to be so cut, or at least the sides of the coils parallel to the axis so lie, and in them are generated impulses of current. The direction of the winding and connection is such as to make the effect accumulative in the coils, so that if the polar projection passes (as in figure 2) over the centre of one coil to that of the next, its lines of force are caused to cut the wire lying between these centres. Impulses of current would thus be set up in both coils, and as the coils are wound each impulse will be superadded. The number of inward pointing poles may be, as in this case, double that of the outward pointing

poles; or it may be the same, when the action becomes a simple cutting in succession by the lines of force emanating from the polar projection, of one side of a coil, or of one side of all the coils taken together, and immediately afterward the other side of the same coil or set of coils.

These actions will be repeated in the coils every time a polar projection passes the wire on either side of the coil, so that if there be six poles, and the revolution of the machine be at the rate of 1,000 turns per minute, there would

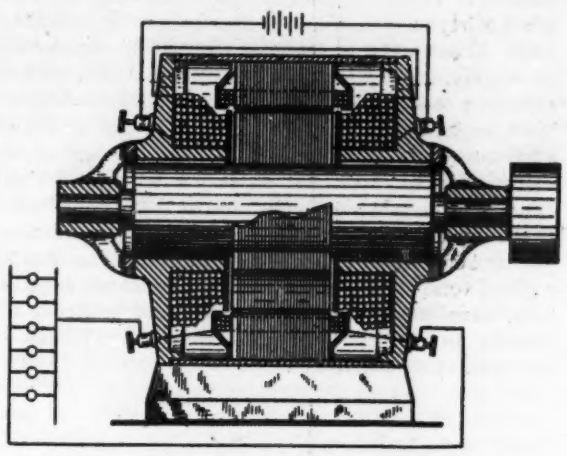
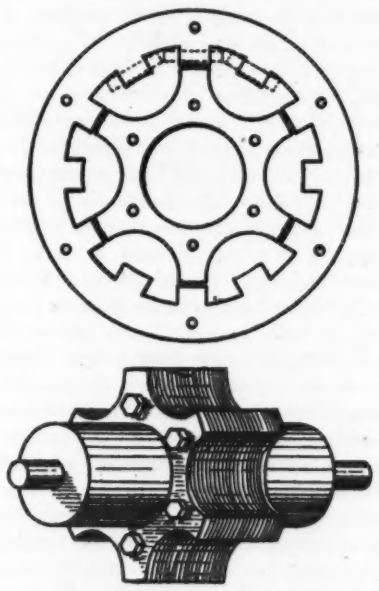


FIG. 1.—PROF. THOMSON'S LATEST DYNAMO.

be 6,000 complete alterations of current per minute. These actions of induction will be accomplished without reversal of magnetism in the core piece, or in the laminated ring structure supporting the coils, and hysteresis will thus be reduced to a low amount. Of course, all cannot be obviated, for the reason that there is a changing of the magnetism of the pole pieces in any case; but it will be reduced to a quantity far less than if the same mass of iron were reversed as usual. It is not necessary then to laminate either the revolving or the stationary poles, and it is obvious that the machine, although described as a dynamo, is equally applicable to the construction of an alternating motor that would possess many desirable qualities; or, by



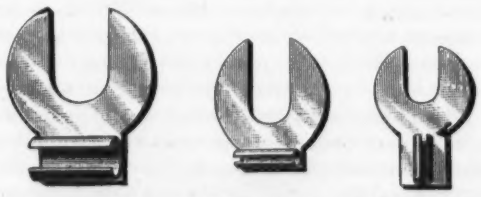
FIGS. 2 AND 3.—SECTION AND POLE-PIECE OF DYNAMO.

the addition of a commutator, be suited to the production of continuous currents.

We think that this description is sufficient to indicate the remarkable properties of the new machine, and although as yet no details of its efficiency are at hand, it certainly appears to be a very simple and effective form of generator or motor. The construction is especially easy and the winding admirable, since there are no moving coils, and therefore no moving contact of any sort, the wires to both field and armature being simply connected to binding posts. The machine certainly is very creditable to Professor Thomson's inventive genius, and, unless we much mistake, will soon be heard from commercially.

Some Convenient Fuse Terminals.

The accompanying illustration shows two varieties of the McIntire fuse terminals. The cut on the left shows the



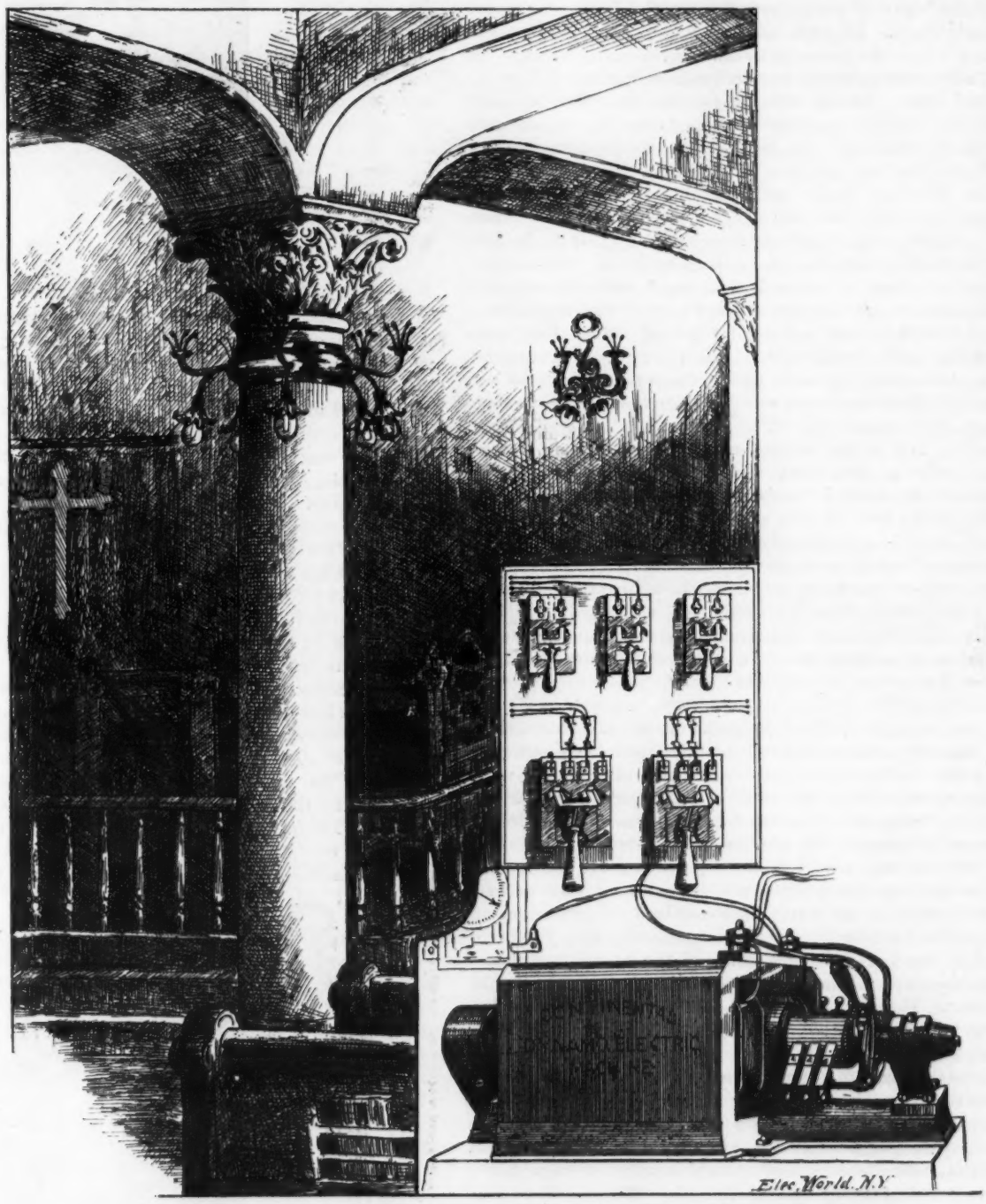
MCINTIRE FUSE TERMINALS.

style in which the larger sizes are made, the fuse being clamped in the clips at the lower end of the terminal. The middle cut is a smaller size of the same style, and the one shown at the right is for the smaller sizes of fuse made in the form of a wire. When a fuse melts out the clips can be easily and quickly applied to a new one.

An Electric Plant in a New York Church.

For various reasons, and mainly because large churches have, as a rule, ready access to central stations, an isolated church-lighting electric plant is somewhat rare; and for the present the plant shown in the accompanying illustration is quite unique in its way. The vestry of St. Andrew's (Episcopal) church, when it was decided to erect a new edifice, wished to be independent of the vagaries of boards of control and subway commissioners, and to establish their own plant in the cellar of the church. In the result they have no reason to be disappointed, and St. Andrew's can now afford to ignore the darkness that has occasionally visited the neighborhood of 127th street and Fifth avenue.

The plant illustrated consists of a New York Safety Steam Power Company's 35 h. p. engine and a Continental dynamo of four hundred lights capacity. At present the church edifice is not completed, and the congregation worships in the basement, which will eventually be used as a Sunday-school room. Our view of this room, which is 100 × 60 feet and lighted by over 100 incandescent



ELECTRIC LIGHTING AT ST. ANDREW'S CHURCH, NEW YORK CITY.

lamps, is taken near the chancel and shows the effects produced by the simple and chaste fixtures used in connection with the pillars that support the main church above.

The dynamos are used on Sundays all day, and on Wednesday and Friday, as well as on such other days as the church may be open. The experiment has proved eminently successful, and the quality, steadiness and economy of the light have thus far given great satisfaction. It is our opinion that isolated plants for public buildings will largely increase in number and in favor as their advantages became known.

A British Co-operative Electric Light Station.

The Kirktonhill Lighting Station is one of the very few instances in which a co-operative scheme of electric lighting has been brought to a successful issue. The difficulty of finding a sufficient number of householders willing to agree each to bear a proportionate amount of the initial and working expenses has generally proved fatal to such projects.

The inception of the present scheme is due to Mr. Archibald Denny, of Dumbarton, whose own residence has been lighted by a separate plant for some years. On his recommendation a number of gentlemen residing at Kirktonhill, a suburb of Dumbarton, decided to have their residences lighted by electric light, the current to be supplied from a central generating station. *Industries* gives the following description of this interesting plant: The building is of brick, two stories high, the ground floor being occupied by the engine and boiler rooms, and the upper floor by the accumulator room. Adjoining the main building, and communicating with it by a door, is the attendant's house.

The boiler is of the "dry-back" pattern, and is 7 feet diameter and 6 feet 6 inches long, and constructed for a working pressure of 160 pounds per square inch. It is stated to evaporate at that pressure, and with Scotch coal, 1,400 pounds of water per hour. This type of boiler is like a return tube marine boiler, but with the combustion chamber outside the shell instead of inside. The outside combustion chamber is lined with best firebrick, and the makers claim that more complete combustion is possible with this lining than can be obtained in the wet chamber or ordinary combustion chamber surrounded by water, where the hot gases are cooled down before entering the tubes. The boiler rests on two castiron chairs, clear of the floor. No external corrosion from contact with any surrounding brickwork is possible, and inspection of the whole outside of the boiler is rendered obviously simple. Such boilers can be kept easily and conveniently clean in the flues, and internally through a manhole fitted on the top and two on the under side of the shell. The smoke box is arranged with a downtake to the underground flue leading to the chimney. The flue from the boiler is carried underground to the chimney, which is 50 feet high, with an area sufficient for a second boiler the same as that described. The steam is led by a 4-inch copper pipe to a separator in the engine room, which insures the supply of dry steam to the engine. Owing to the high steam pressure in use, Mr. Peter Denny, Jr.'s, system of strengthening the steam pipes by "strapping" has been adopted. Bands of round iron (spaced about two diameters of the pipe apart) are heated and bent round the pipe, and the ends twisted together while hot. When the iron cools the pipe is strengthened by the bands shrinking and binding it firmly. The whole is covered by the non-conducting covering.

The engine is one of Messrs. Willans & Robinson's F F triple-expansion type, coupled direct to a Siemens dynamo, giving an output of 180 ampères by 160 volts at a speed of 425 revolutions per minute. The exhaust steam is led through a feed-water heater, or alternately direct to the chimney. All the drains from the engine, piping, boiler, etc., are led into a brick-lined chamber, which is drained

by a suitable pipe. The disadvantage of blowing steam into the drains is thus avoided.

There are at present erected two accumulators, each of 60 cells of the 31 L type, made by the Electric Construction Corporation, Wolverhampton, and the racks are arranged and all the connections are already provided for a third set, which will be erected before the coming winter. The switching arrangements are very complete, and admit of any combination with the dynamo, accumulators and the distributing circuits, of which there are four. The instruments are all of Sir William Thomson's newest types, with large scales. A volt gauge and an ampère gauge are constantly in circuit with the dynamo, and an ampère gauge is permanently in circuit with each battery. An excess current alarm is also fitted in each battery circuit, with the bells arranged to ring in the attendant's house. The main distributing circuits, of which three are at present laid in various directions, are each about 1,000 feet long, and terminate in junction boxes. From these junction boxes the house mains radiate. The cables used are 37-13 and 19-12, insulated with Callender's bitumen, and laid underground in heavy red pine casings treated with Archangel tar. A pair of check voltmeter leads are laid with each pair of mains from the junction box to the main switch board. An Aron meter is fixed in each consumer's house where the potential is 110 volts.

The furnishing of the station has been carried out on a liberal scale. Among other apparatus the following may be noted: A small traveler is erected over the engine and dynamo, affording ready means of manipulating the parts. A trolley has been adopted for handling the accumulator cells; this has been found much less expensive and more convenient than an overhead traveler. The trolley is made in two stories (the upper one detachable) to suit the height of the shelves of the racks. It is mounted on india-rubber tires, and may be wheeled close up to the rack, and any cell is easily drawn on to it across a pair of wood straps, and then wheeled under a fixed block and tackle. One man can thus easily handle cells of the 31 L type. For convenience in handling the acid a leaden acid pump is fixed on the wall of the engine room with its suction pipe projecting through the main wall. The carboys are brought along outside, and a few strokes of the pump empty a carboy into a lead-lined teak-wood tank, having a capacity of about 10 carboys, which is fixed above the cells on the wall of the accumulator room. From this tank an acid service pipe of lead is laid, having on its branches leaden taps with earthenware plugs. On these taps india-rubber tubes are fixed, whose free ends terminate in ¼-inch vulcanite taps by which any cell may be reached. Only those who have had much experience of filling accumulators by hand vessels can appreciate the advantages of such a service. A diary in monthly parts, with printed headings and with monthly summary, is provided in the engine room, to be filled up by the attendant. From this, the total production and cost per electrical horse power at dynamo can be accurately determined and compared with the consumption as registered by the meters in the various houses, beside other useful data, such as average life of lamps, periodical insulation tests, etc.

The contractors were desirous of having all the houses supplied from this station wired on a concentric system which provided for a very high standard of insulation of the central conductor, the outer conductor being earthed; but on account of the opposition of the insurance companies they were obliged to fall back upon the usual double wiring. This has been carried out on a system which has been adopted exclusively for housework by the contractors. The main cables are led to a central position in the house where they terminate in the distributing bars of a double-pole fuse box. From this fuse box all the branch conductors radiate. The branch conductors are all of the same size—viz., 7/21¼, highly insulated with vulcanized india-rubber, each branch carrying eight lamps of 16 c. p. each. The section of the conductor is nowhere reduced. The 7/21¼ or its equivalent is carried into every switch and every lamp-holder, except in the case of branch arms of electroliers. There are, therefore, no fuses in the house except those in the central fuse-box. In large houses one fuse-box is provided for about each 100 lamps. Each fuse is numbered, and a schedule fixed inside the lid indicates the room or section of the house to which it corresponds. The fuses (of tinfoil) are mounted on porcelain saddles with copper contacts, which are pushed firmly between fixed contacts. All the fuses are of the same size and melt with 10 amperès; as they are interchangeable no harm can be done by inexperienced hands inserting them. No terminal screws are used either in switches or lamp-holders, the wires being soldered to the contacts in each case, thus entirely abolishing the risk of faulty contacts, and insuring absolutely perfect and permanent conductivity. The conductors throughout are encased in grooved teak-wood runs with screwed covers, each wire being laid in a separate groove.

This method of wiring, although initially more expensive than that usually adopted, gives absolute immunity from the trifling mishaps, such as lamps going out from faulty contacts, broken wires, etc., which are too often incidental to electric lighting. It may be objected that when a fuse melts a number of rooms may be left in darkness. But as a matter of fact it is found that when the work is carried out as above described the fuses do not melt.

A Street Railway Pole Top.

A glance at the electrical railways in this country will show a number of poles of different designs now in use. How serviceable the different forms are will depend partly on the rigidity of the pole and partly on the design of the pole top. That the pole should stand a great side-pull without much bending was early recognized, but only lately has due attention been given to the features needed in a good pole top. This should be strongly made, so shaped as to shed the water, and should insulate both trolley and guard wire from each other and from the pole. Then there should be ready means for taking up the slack in both suspension wires, and there should be provided also insulators for carrying the feeders. These features all seem to be found in the new pole top designed by Edmund

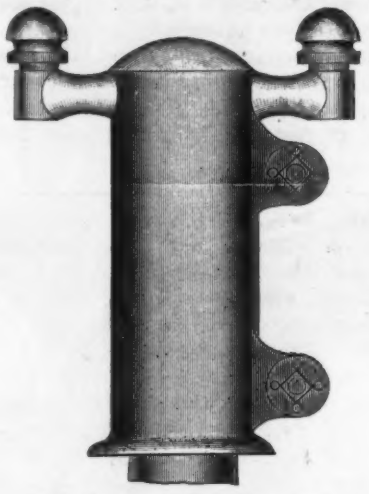


Fig. 1.—Improved Pole-top.

Verstraete, the electrician in charge of the construction of the Union Depot Railway Company's plant in St. Louis, and made and sold by the Great Western Electric Supply Company, Chicago.

As the accompanying illustration shows, this pole top is an iron cap which may be used with either iron or wooden poles. The wooden poles do not need to fit it tightly, as the pull of the guy wires will keep it pressed against one side of the pole. With iron poles a wooden plug and bushing is used, as shown in the section. These bushings are thoroughly soaked with Simplex paint, and as the iron flange keeps the adjacent part of the pole dry, the top is always insulated from it. The lower end of the pole top is flared out so as to shed the water, and keep the upper part of the pole dry, thus insuring the insulation of the trolley wire from the ground.

The suspension wires are wound on drums, whose enlarged ends have six holes, and a pin through one of these holes keeps the drums from unwinding. These pins cannot drop out, yet allow the slack of the wires to be readily taken up. The drum for the guard wire is nine inches above that for the trolley wire, and is made of insulating material. The insulators for carrying the mains or feeders are above the guard wire. Then if both the trolley and the guard lines are put up before the mains are, the latter

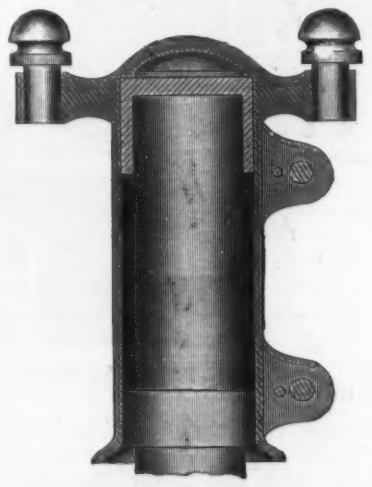


Fig. 2.—Section of Pole-top.

need not be slipped through between the suspension wires, but are readily thrown over the top and fastened to the insulators. The whole is well built, simple and inexpensive, and seems to be a very practical pole top.

The Modling-Hinterland Electric Railway.

In a recent number of the *Révue Générale des Chemins de Fer*, M. Maurice Bellom gives some particulars with regard to this line, the first section of which was in operation as far back as 1883, and the last section of which was completed in 1885. The line is of 1 metre gauge and 4.4 kilometres (2¾ miles) long. The steepest gradients are 1½ per cent., and there are some curves of 100 feet radius. The plant comprises one 140 and three 15 h. p. engines and six compound-wound Siemens machines, having an output of 30 ampères at 500 volts. The motors, which are series-wound Siemens machines, are arranged under the car, spur gearing being used, and the speed being reduced in the ratio of 6 to 1, the cars running as a rule at the rate of 9½ miles per hour. The circuit is entirely metallic, and runs overhead on wooden posts 18 feet high and 90 feet apart. The conductor consists of a split iron tube, in which there slides a brass contact piece attached by wires to the roof of the car. To take the strain off the conducting wires, the slot is pulled along by means of a rope. The contact piece lasts for about two months without renewal.

During the winter only one train is employed, but during the busy season three trains, and on Sundays and fête days six trains, are running simultaneously. Each train consists of a thirty-passenger motor car, weighing 4.1 tons, and a thirty passenger car without a motor, weighing 2.8 tons. These weights, together with a full complement of passengers, make a total load of 11.1 tons. The maximum resistance to traction is found to be about 24 pounds per ton. With six trains running, 8,000 passengers can be carried in a working day of 14 hours. Tests have shown that with a single train at work, the difference of potential at the dynamo terminals is 500 volts, and at the distant terminals of the line 390 volts, the current strength being 30 ampères. The first cost of the line was somewhat high, amounting to a grand total of 1,317,714 francs. The working expenses in 1887 were 36,645 francs, leaving a net profit of 67,539 francs. In 1888 the net profits were 71,089 francs, or 5.4 per cent. upon the first outlay.

Legislation in Massachusetts.

The length to which legislative interference might go if not restrained by a sounder public opinion is shown in the report of Messrs. Burdett and Gooch, counsel of the Massachusetts Electric Lighting Association, in which the propositions considered at the late meeting of the Legislalature are enumerated.

Included among them are numerously signed petitions for the passage of a law to authorize cities and towns to establish and operate gas and electric light plants for both municipal and commercial purposes, and a special enabling bill in favor of the town of Wellesley; several propositions to curtail the powers and impair the authority of the Board of Gas and Electric Light Commissioners, and at least one direct proposal, urged with great vigor before the committee, to wholly abolish the Board and repeal the laws under which it operates; a bill to establish a State Board of Electrical Control, and another to create a commission to have the entire control and supervision of all electric light wires in the State; numerous orders looking to further municipal regulation of and control over the erection and maintenance of electric wires, and the protection of the public against accident to life and property from dangerous currents; a proposition to make owners of electric wires "responsible for all injuries to persons or property from said wires, which are not caused solely by the negligence of the party injured;" orders to require the marking or tagging of all wires, and the keeping of proper records of ownership, for the benefit of the public; a bill to give special privileges to a new electric light company in a certain city of the Commonwealth, and another to override the decision of the Gas Commissioners in favor of the first-established company in a certain town; an order to prohibit the use of electrical currents of high intensity; a bill to create a State inspector to measure the candle power of electric lights and test the accuracy of electric meters; and a bill requiring the sale at public auction of all future franchises to use the public streets with structures, wires, or conduits, and limiting the term of years during which such franchises shall continue.

This list is almost appalling; but it is satisfactory to note that out of all this mass not a single piece of oppressive legislation was finally passed.

Indeed, the only important measures which became law by reason of the extraordinary agitation of the subjects above mentioned were the bill to allow electric light companies to mortgage their franchises as well as their tangible property, and the bill requiring further and more effective municipal regulation and control of overhead and in-door electric wires. As to the latter, the report says:

"The one important law hereinbefore referred to as having resulted this year from the unusual and unreasonable agitation of the wire problem is chapter 404 of the acts of 1890, entitled 'An act relating to the regulation and supervision of wires over streets or buildings in cities.' It is confined in its operation to the cities of the commonwealth, but relates alike to electric light, telephone, telegraph and all other kinds of wires. Those companies, therefore, whose business is confined to the towns of the State where the wires have not become numerous, complicated, or dangerous are not affected by the law; while all companies doing business in cities are alike subject to its provisions. In the cities to which the law is applicable the results will, in our judgment, fully justify its passage. The removal of all "dead" wires, the thorough insulation and marking of all "live" wires, and the efficient municipal control and supervision of the whole system of wires in cities will ultimately be of great advantage to the companies themselves, as well as to the public at large.

The question of municipal ownership was referred by the Massachusetts Legislature to a special committee, which, after an elaborate investigation, including trips to Richmond, Va., and Philadelphia, Pa., unanimously concluded that the innovation would be inadvisable. The bill looking to that end, however, passed the House; but it was scotched in the Senate.

The Lake Superior Mining Region.

BY F. DE LAND.

No section of the known world is so rich in mineral wealth as the Lake Superior mining region, aptly termed "the treasure house of the nation;" a region that already has enriched our country to the amount of several hundred million dollars, and from which nearly 50,000,000 tons of iron ore and 650,000 tons of copper have been shipped, to say nothing of other metals.

This mining region lies entirely in that section of Michigan to the north of Wisconsin, and best known as the Upper Peninsula, with one range slightly overlapping the latter State, and is divided naturally into three sections locally called the Keweenaw, the Marquette and the Gogebic. From the latter two come the shipments of iron ore, while the former is the great copper producing section of the world.

Who first discovered the metallic wealth of this section it is difficult to say, for traces still exist in the copper region showing the rude efforts made by hands that probably wielded tools of stone, so little did they apparently accomplish. As to whence those early miners came, or where they found final resting place, naught is known. But we do know that early in the seventeenth century came the missionaries and the fur traders and Father Marquette, that noble pioneer, and they soon learned that copper had been found along the shores of the great inland sea; and that was all. Two hundred years then passed before mining as an industry began.

During the years 1844-45 a few tons of copper were secured from a mine or two in the vicinity of Eagle River, and by 1852 the output had increased to 2,500 tons, which was shipped on sailing vessels to Detroit at an expense of $12 per ton and was valued at an average price of 20 cents per pound.

Then followed the accidental discovery of the Marquette iron ore belt by a party of surveyors while investigating the cause of unusual magnetic variations in their instruments, continued search showing rich deposits of hematite and magnetic ores. To-day, seventy-three mines are operated on the Marquette Range.

The success that followed the opening of these mines inspired the search that led to the discovery of the vast ore bodies in the Gogebic Iron Range. But as no copper was found, little appears to have been done till 1883–4, when the Colby mine was opened. This range extends from the vicinity of Gogebic Lake in Michigan to that of Bad River in Wisconsin, a distance of about fifty miles, with a general east and west course, the regularity of the formation, the magnitude of the deposits and the uniform high grade of the ore proving a source of surprise to mining engineers.

The mines on the Gogebic that have made the range famous, and now constitute its great industry, lie between Ironwood and Bessemer, a distance of only eight miles, and taken in their order from the Montreal River (the dividing line between the two States, as well as between Hurley and Ironwood) are the Superior, Ashland, Norrie, East Norrie, Aurora, Pabst, Mount Hope, Federal, Colby, Palms, Anvil, Dangler, Brotherton and Comet.

The Superior, Aurora, Colby, Palms and Comet (formerly known as the Eclipse) are all operated under the general management of Mr. Alton L. Dickerman, an accomplished gentleman of high repute as a mining engineer, who has charge of all the vast mining interests of the Wisconsin Central, Henry Villard and the Colbys. Mr. Dickerman is also general manager of the Ironwood Electric Company and the Gogebic Electric Company, of Bessemer.

When Mr. Dickerman assumed charge of the mines named he found so unsatisfactory the antiquated and expensive method of illuminating the mines by means of candles placed in the hats worn by the miners, or in a steel socket having a sharpened extremity that permitted it to be stuck in any convenient piece of frame work, that he decided to carry on a series of experiments to settle the vexed question of mine lighting. He also found that the dim light afforded by candles had not only proved expensive through retarding rapid work, but had also been a constant source of danger whenever they were left burning in the sockets stuck in the timber frames, several fires having been traced to this cause, notably in the Germania mine, where a number of lives were lost. And, though these facts were known to all, no mining engineer had cared to risk his reputation and his employer's capital in carrying out experiments that might prove flat failures.

Mr. Dickerman's first step was to consult with the Thomson-Houston Electric Company, and they placed the entire matter in the hands of their Mr. Frederick N. Bosson, now the manager of the Northern Thomson-Houston Electric Company, with headquarters at Marquette, Mich., who made a thorough survey, and after a month's study of the conditions under which a plant would have to be installed, decided that the lighting of the mines with incandescent lamps was both feasible and safe. Mr. Dickerman then formed the Ironwood Electric Company, the stock of which was subscribed for by the different mine owners, who, dubious at first, were soon convinced of the ultimate success of the plans by the earnestness of the projectors. The next step taken was to secure the necessary machinery and electrical apparatus for an experimental plant, and to contract for the erection of a station. The station constructed is a neat, convenient brick structure, 160 by 80 ft. in size. The dynamo room is 110×80 feet, facing north, with offices in one corner, and bath room, dressing room and closets in the opposite corner. In the rear of the dynamo room and separated therefrom by a 20-inch brick wall, is the boiler room, 48×80 feet, containing four boilers of 125 h. p. each, having 60 four-inch flues. Two Reynolds-Corliss engines, one 18×42 inches, the other 24×48 inches, developing over 600 h. p. at 80 revolutions with 90 pounds of steam, stand in opposite corners of the dynamo room and are belted to Eclipse clutch pulleys by a 22-inch and a 36-inch Munson's leather belt. Special belt tighteners are used that hold the belt in proper position in the event of one side being stretched more than the other. Two 650 light and one 1,300 light dynamos of the Thomson-Houston alternating current type are now in position and additional dynamos to increase the total capacity of the station to 6,000 lights are now en route or ordered, the switch board now in use containing the regulating apparatus for that number of lamps. East of the station is a frame building in which are kept the tools and supplies required in the further construction and maintenance of the plant, and adjoining that is the neat dwelling occupied by the station force. From this station a strongly constructed pole line was built and Simplex weatherproof wire strung to the respective shafts. And then the actual work began, and the difficulties encountered in successfully carrying the circuits down the shafts would have disheartened any man not as thoroughly wrapped up in his work as Mr. Dickermann and Mr. Bosson have been. Then the aversion of the linemen to the new features of their work had to be overcome, for men ordinarily do not like to work by candle light while let down and held in position in the shaft by means of a rope, or while standing on a narrow board one end of which rests on a rung of the ladder and the other in a swinging support, and this when a fall meant a tumble of several hundred feet. Then there was the unusual physical exertion required in climbing the long ladders, often from a depth of 400 feet to 1,000 feet, usually producing symptoms of nausea and faintness at first. But these and other disagreeable symptoms were forgotten in the deep interest and hearty co-operation of all in making a complete success of Mr. Dickerman's plans.

It was soon found that the real difficulties to be overcome were of a mechanical rather than of an electrical nature, beginning at the mouth of the shaft and presenting themselves at every "level." It was an easy matter to drop the feed wires to the lower "levels" and then to branch out, but at first the "feeders" of to-day were gone to-morrow, torn from their supports by falling timbers, rock and ore. After months of experiments that proved far more costly than any one can realize, that problem was solved, and to-day forty-five shafts are completely wired with double circuits. And no two of these shafts presented the same difficulties, nor could the style of work that proved satisfactory in one be adopted for the next. In one shaft dripping water that deposited a reddish precipitate on everything it came in contact with was the prominent evil to be overcome; in another the liability of injury from falling objects must be strongly guarded against; while a heavy damp atmosphere prevailed at times, and the condensation of the moisture in the atmosphere of the levels was sufficient in quantity to fill rapidly the ordinary cast-iron fuse boxes.

The shafts vary in depth from 450 feet to 1,000 feet, and in the majority the feed wires pass from the overhead pole line to the mouth of the shaft and into heavy moulding consisting of two pieces of timber, grooved deeper than usual to hold the wire, and having a cap of the same size log screwed to it. These mouldings vary according to the conditions and in size range from 4 × 8 inches to 8 × 14 inches. They are first kiln dried, and while still warm thoroughly coated with Simplex paint which permeates the fibre to the depth of an inch or more, thus forming a waterproof coating that prevents the absorption of moisture and preserves the wood from mine damp and rot. When the work was first being installed, a visitor doubted the necessity of such heavy moulding. Hardly had his criticism ceased when the loaded "skip" (or ore car) on nearing the surface, jumped the track and dumped several tons of ore down the "skipway," some of the heavy chunks in their rapid descent bounding against and tearing away an 8 × 10 inch iron bound moulding and actually breaking a portion of the platform on which the visitor stood. He then remarked that if he had a mine to wire he should "build a special shaft, run his wires and then fill the shaft with insulating material."

Occasionally a dry shaft is met with and in one of that character it was only found necessary to run a special heavily insulated wire through Okonite tubing previously clamped to the outer edges of the skipway rail guards. In almost every shaft the wire used is a special make prepared by the Simplex Electrical Company from specifications furnished by Mr. Bosson, and having a coating of pure Para rubber thirteen thirty-seconds of an inch in thickness, over which is placed a three ply braid of Simplex covering, each braiding being separately and thoroughly saturated with their compound. This wire has been in constant use and given excellent results, and the last test taken showed the insulation resistance of a length of over 1,000 feet to be more than five megohms.

As previously mentioned, two complete circuits are carried through each mine, and in wiring the various "levels" the circuits pass to a point half way between each shaft. From 150 to 500 lamps are in each mine, and are placed about 45 feet apart, alternately on the two circuits; thus if one circuit is injured by the falling of ore, timbers, rocks or otherwise, the lights on the other circuit will still continue to burn until the necessary repairs could be made. The lamps are protected from injury from above by a 10 × 12 inch timber, and are covered by a screen made from No. 4 steel wire with 2 inch mesh, which prevents accidental injury to the lamps either from timber or tools carried in the hands or on the shoulders of the miners. Each lamp is supplied with an individual cut-out and fuse box, the enclosing box being made of iron from special patterns, with the gasket placed underneath the cover, while the space on the side of the box into which the wires pass is packed with hemp in the same manner as an ordinary steam joint is packed, and then melted Chatterton's compound is poured over the hemp, this extreme care being necessary owing to the rapid condensation of the moisture in the atmosphere.

There is also a larger cut-out and fuse box of this special pattern placed in circuit for every 10 lamps, and should one end of a circuit be accidentally broken, grounded or short circuited, it will only blow the fuses in the first box and thus cause but little inconvenience.

As previously stated, the Thomson-Houston alternating current of 1,000 volts is used, and the converters are placed in the shaft and so protected as not to be injured in any way or from any cause other than an earthquake or some great disaster, their usual resting place being a space hewn out of a solid rock. The converters are as carefully protected from the destructive effects of condensed moisture as the other portion of the apparatus used underground.

A "room" is that portion of a mine where they break down the ore. Here three 16 c. p. lamps afford ample light and greatly facilitate the work of mining. These lamps are usually placed on portable fixtures and arranged to throw the light on any desired point. If the lights in a "room" give satisfaction, then, from a miner's standpoint, the entire system is a success—and *vice versa;* as at this point perfect light is of the greatest service and returns its cost a hundredfold in the extra amount of ore that it aids in breaking down. But it has been found quite difficult to secure a flexible duplex incandescent cord or cable having a carrying capacity of a No. 14 or 16 copper wire that will satisfactorily answer the requirements here presented. It must not only give the necessary electrical efficiency and remain extremely flexible, but be so strongly made as to withstand the mechanical injury that will naturally result from the falling thereon of timber, ore and rocks, the heavy tread of miners' boots, etc. Such a flexible armored duplex cord can be made, and now that mine lighting with incandescent lamps has proven a success a demand for a considerable quantity of such a cord will spring up.

All the lines and circuits are interchangeable and have been so constructed in the "levels" that they can be quickly taken down from one level and replaced in a new one whenever necessary, thus effecting a saving in the cost of installation that is appreciated by all mine superintendents.

In accepting this plant the local company could not speak too highly of the work done, in electrical as well as in mechanical engineering, and referred to the fact that "the dynamos have proven themselves by cards taken from the engine to be automatic in the power they consumed in proportion to the number of lights burning and the regularity of the candle power of the lights." A state inspector wrote: "I have seen the Thomson-Houston incandescent lights in operation in the mines during the past two days, and I consider them a wonderful improvement over candles. The shaft is so clearly lighted from surface to fifth level that every ladder rung can be distinctly counted. This one thing is of immense value, as a broken rung can be noted by a downward glance. The lighting at the dump stations and plats shows with distinctness the skipholes and manholes. The fifth level is very crooked and yet I am free to admit that the lighting is so perfect that I can walk from one end to the other without a chance of a misstep."

So much for what has been accomplished at Ironwood by the indomitable will and pluck of Mr. Dickerman and Mr. Bosson.

Eight miles distant from Ironwood is Bessemer, and here the Gogebic Electric Company, of which Mr. Dickerman is treasurer and general manager, has contracted with the Thomson-Houston Electric Company for the installation of 2,000 incandescent lights, to be used in commercial and city lighting and in lighting the well-known iron mines Federal, Colby, Pabst, Dangler and Anvil. When completed this will be one of the handsomest and probably the most compact station in the country, every detail having been worked out by a master hand.

From Bessemer, or rather from Duluth, the main line of the Duluth, South Shore & Atlantic Railway crosses the Gogebic and the Marquette ranges, and a branch of this road runs to Houghton in the copper country, distant 48 miles from the main line. At the present season of the year a trip over that branch line will reveal a richness and diversity of scenery that is simply entrancing to the visitor from the low lands. The limpid water in the great bay reflecting back the image of the pine-clad hills or the habitations of the natives; the view of the Indian mission

high up on the hill and the memories awakened thereby; the busy hamlets on the opposite side of the bay, and finally a view of the smelters and a portion of the mines, keep the traveler's attention enchained till all thought of time or distance is lost and the trip seems far too short as the train rolls into Houghton.

Here Mr. James R. Dee, the general manager of the Peninsula Electric Light and Power Company, has a very neat electric station containing a Ball and a Porter engine and six Thomson-Houston arc light dynamos. From this station the current to light both Houghton and Hancock, the town on the opposite side of Portage River or bay, passes through some 40 miles of overhead circuit, while six armored Okonite cables carry the current across the bay. Mr. Dee is arranging for the construction of a new station, probably on the Houghton side, but as close to the drawbridge as possible, and will then add an alternating current incandescent plant. At the present time there are in operation several hundred incandescent lamps in series on the arc circuit, those of 16 c. p. being placed in groups of five with individual resistance, while the larger lamps are cut in directly without distributors of any character. This method has given perfect satisfaction from the start, no case of short-circuiting having occurred, nor has the plant been shut down a single night since starting.

Mr. Dee is also the manager of the telephone exchanges and the telegraph offices in the copper belt, and completes his circuits across the bay by means of two Patterson armored telephone cables, each 1,100 feet in length, one having 52 conductors, the other 27.

Both Houghton and Hancock are beautifully situated, and when the lights appear on the hillsides at night with a deep background of dark green pines, the sight is one not soon to be forgotton. The State school of mines is located at Houghton, and a special course in electrical engineering is afforded the students.

The other important towns in the Keweenaw range are Lake Linden, Red Jacket and Calumet. At the latter the Calumet and Hecla Company are arranging to have an 80 h. p. Brush motor placed on the lower level to aid in the work of deep pumping. No work other than preparing a foundation for the 100 h. p. Brush generator has yet been done, and no plan for carrying the circuits to the lower levels of the mine has yet been fully decided on, though the indications are that a hole about a foot in diameter will be bored from the surface to the lower level, a standard iron cable suitably insulated suspended therein and the necessary circuit wires attached thereto. Practical experience can only determine whether the conditions to be met with will prove this method to be efficient and satisfactory.

Every process connected with the transformation of the crude ore into copper cakes is interesting in the extreme and a week can profitably be spent in inspecting the different points from the lower level to the Corliss compound engine of 3,000 h. p. and then to the stamp mills, smelters and wire mills. In the Calumet mine are more than thirty miles of streets, many of which are a mile in length, and the day may come when the ore will be taken out on trains drawn or propelled by electric motor power. On the contrary, it is doubtful if this will ever occur in the iron mines owing to the short distance, about 100 feet, that the ore cars are hauled, and generally the men loading the car can more quickly push it to the skipway than it could be moved by other means.

The towns of Calumet and Red Jacket are both supplied with the Thomson-Houston arc and incandescent lights from the station house located at Lake Linden, five miles distant, the current being carried on a circuit of five No. 1 Roebling's weatherproof wires strung on strong poles, each having a six pin six-foot cross arm double-braced thereto. Altogether some fifty miles of circuit are or will be shortly in use on this line, which follows the crooked winding roadside through a thick tract of timber in passing from Lake Linden to Calumet, and is probably the only circuit of its character in the country.

The station was erected at Lake Linden owing to the continued economy that would result from the use of cheap fuel and water, the latter costing only the expense of pumping. The best Pittsburg soft coal costs but $3.50 per ton laid in the furnace room at Lake Linden, being brought almost to the door in vessels from Cleveland, while at Calumet it would cost $4.50 per ton, and the item of expense for water can be guessed at when it is stated that the water used in the mines and in the residences for domestic purposes is pumped up hill from Lake Superior, five miles distant.

In the Lake Linden station are two 100 h. p. Williams engines that drive the shafting with Hill clutch pulleys, to which are connected with Schieren's electric perforated belts a 30 and a 50 Thomson-Houston arc light dynamo and two Thomson-Houston alternating current machines. The conductors pass from the dynamos through glass tubing to the switchboard which is of the open latticed pattern, adopted for its freedom from danger through nothing being concealed thereon. From thence the wires pass out through a capacious, convenient tower, and it is worthy of note that, though this station is nearly at "land's end," yet not a single conductor comes in contact with wood anywhere within the building, glass rods and insulators being used everywhere. The station is a handsome brick building 50 × 100 feet in size, with heavy wall separating the dynamo room from the boilers. Adjoining is a frame dwelling for the foreman and engineer, and a frame stable and supply house. Ample precautions have been taken to prevent loss by fire, and every portion of the station shows the careful manner in which all the details were worked out, while the subscribers are delighted with the perfect service afforded.

At Dollar Bay, where the strongly built wire drawing mills are located, three of the largest size Thomson welding machines are in use and are giving excellent satisfaction.

The great masses of copper weighing oft times from 10 tons to 50 or 60 tons sometimes present a handsome appearance before being broken up for the stamp mill, the carbonate ores exhibiting shades of blue or green, while the red oxide often show crystallized fragments of a golden color. By what action of nature these masses of native copper were deposited is yet to be ascertained, but in referring to the subject, Dr. M. E. Wadsworth of the Houghton School of Mines said: "That the copper was deposited from water, with or without electro-chemical action, is shown by the fact of its being found inclosed entirely in minerals known to be formed by water only; also by its enclosing such minerals; by its being found in disconnected or isolated masses in the lavas and elsewhere; and by its greater abundance where there are the most signs of water action. Had the copper been deposited by igneous agencies it would have had a channel or line of passage, and been continuous along that line of passage, while all the different masses of copper would have been connected together downwards.

"The copper seems to have needed for its deposition rocks that were porous and cellular, those whose parts were easily removed by the percolating waters, like melaphyrs or the cementing mud of the conglomerates, and the open spaces of veins and fissures. In truth the copper seems to have been deposited wherever there was found any place to put it. From the fact that the copper is generally found most abundantly under the heavy lava flows, and associated with minerals evidently the production of the decomposed lavas, it appears probable that the copper was once finely disseminated through the lavas and has since been concentrated by waters percolating through them. Had the copper been derived from the sandstones, then one would suppose that under them should be found the greatest supply of copper, but such is not the case. That the course of the copper was generally downward is indicated by the finding of spikes of copper and calcite extending from one bed down into others, with the small end downward like an icicle; by the fact that when the copper is not uniformly distributed throughout the bed it is apt to be more abundant in the upper portion, and by the fact that the largest masses have usually been found in the upper portions of the veins.

"That the copper was deposited after the copper-bearing series was complete is shown by the fact that it is found in fissures extending across the beds, and which could only have been produced after the beds were in place; by the fact that the copper was deposited subsequently to the jointing of the lavas, owing to its now being found wrapped around the pieces formed by jointing, the same as paper is wrapped around a piece of soap; and by the extension of the copper from one bed down into another as a continuous mass."

Leaving the country in which copper alone is the king, and running along the picturesque shore of the bay to Nestoria (where the main line of the South Shore road runs through to Marquette and on to Mackinaw City), the entire length of the Marquette mining range is quickly passed over. Here there has been but little employment made of electricity other than the lighting of the grounds surrounding the buildings with isolated plants. At Ishpeming some of the mining companies are supplying arc lights, and there is strong talk of constructing an electric railway to connect the neighboring town of Negaunee, three miles distant, where the Iron Cliffs Company is operating a Western Electric arc light plant, and in the vicinity of which many traces of gold have been found. The possibility of extending an electric road to or from Marquette has also been discussed and appears somewhat feasible should a sufficient water power be secured, though the main feeder would probably have to be full fifteen miles in length.

At Marquette the Hon. Timothy Nestor is planning to install an electric street railway that will run through the principal portion of the city and out to Presque Isle, the romantic picturesque headland two miles north that was presented to the city by the Government to be converted into a park, and is the resort of all visitors to the city. Whatever system is adopted, this line will have to climb a ten per cent. grade for 350 feet on the main street, and on the return trip a three per cent. grade for a stretch of 4,000 feet. But the road is certain to prove profitable from the start owing to the number of visitors and to the absence of competing lines of any description.

Marquette has a population of some 12,000, and is certainly one of the most delightful summer resorts to be found anywhere; for the air is always cool, and the soft twilight lasts till bedtime. Some six months ago the city completed the details that have since enabled her citizens to enjoy the blessing of electric lights under conditions somewhat novel. As a general description of the plant was given in THE ELECTRICAL WORLD of March 1st, 1890, it need only be mentioned that for a reasonable sum of money the city secured possession of a tract of 400 acres, distant some three miles from the city, including the water power of Dead River (so named from the death of some 50 Indians that were slain in a combat on its banks) at that point. Here a station was erected, and to-day the streets and stores are brilliantly lighted with the Brush arc lamps and the Westinghouse alternating incandescent, either form of lighting being furnished to occupants of stores and residences at prices that appear ridiculously low, and yet are growled over by some of the merchants, so perverse is human nature. To accomplish all this, it was only necessary to bond the city for $50,000, and already the land remaining will bring that sum if offered for sale, leaving the city the gainer by a valuable water power and a substantial electric lighting plant. The control of this property is in the hands of the "Water Power and Lighting Board," composed of the leading financial men of the town, who have adopted the following scale of prices per month:

Parlor lamps, 16 c. p.	25c. each.
" " 25 "	40c. "
Dining room (used only as such), 16 c. p.	25c. "
" " " " " 25 "	40c. "
Dining and sitting room (combined), 16 c. p.	40c. "
" " " " " 25 "	55c. "
Library lamps, 16 c. p.	40c. "
" " 25 "	55c. "
Kitchen " 16 "	40c. "
Hall " 16 "	40c. "
Bedroom, closet, basement, etc., 16 c. p.	12½c. "
Store and office lamps, 16 c. p.	40c. "
" " " 25 "	55c. "
" " " 32 "	65c. "
" " " 50 "	$1.00 "
Arc lamps, 2,000 c. p.	6.00 "

Incandescent lamps of larger sizes than those above enumerated may be used, and a rate for the same will be made by the Lighting Board on application.

Lamp renewals will be at the purchaser's expense, as will also be the wiring between the converter and the lamps.

For arc lighting the Lighting Board will furnish the lamp, furnish carbons for and carbon the same, but the purchaser is to bear all other expenses connected with putting in and operating the lamp. In all places where arc lamps are used a suitable switch must be placed on the outside of the building, so that the current may at any time be switched off should that become necessary from any cause.

In case of any accident to the machinery or wires by which the Lighting Board may be prevented for a time from furnishing the electric current as agreed, no charge shall be made for such interval, and the purchaser waives all claim for any loss or inconvenience that may be thereby caused.

One of the advantages resulting from the establishment of this lighting station has been the reduction in the price of gas to $1.50 per thousand feet. And now it is rumored that the gas company proposes to install a complete arc and incandescent plant before long, though it hardly seems probable that it will carry out this plan in view of the low rates now prevailing. It is merely a repetition of the old story; the gas company might have controlled everything had it only respected the people's desire for an absolute necessity, the incandescent light. But it preferred to laugh at the idea of any one else furnishing the light till awakened from its delusion by the city. And now it is puzzled to know by what right the city dares injure so important an industry and one that has paid the city such heavy taxes and done so much to improve the place as the gas company has done.

There are no street railways in operation in the towns on the mining ranges and it has been suggested that an electric road connecting Ironwood and Hurley would prove a profitable investment, but the present indications hardly point that way to an outsider. Whether an electric road connecting Calumet with Red Jacket would pay can probably only be settled after a consultation with the officials of the Calumet and Hecla.

Electricians, as well as ordinary mortals desirous of passing their vacation in a profitable yet interesting manner, cannot go far out of the way by taking a trip over the "South Shore" line to Houghton and Ironwood and thoroughly inspecting the electric work that has been or is being done in these regions. Certainly many of the delegates to the Edison Convention to be held at Minneapolis in September can take in this trip without much loss of time. And what would be more enjoyable for many of the visitors to the telephone meeting at Detroit in September than to go by boat to Mackinaw, Marquette and Houghton and by rail to Ironwood?

Sparks from Belts.

An interesting note comes from a correspondent in Woonsocket, R. I. Some time since there was trouble with one of the arc machines in use, and after a careful investigation by Mr. Pierce, the electrician who kindly furnishes the facts, it was found that the static discharge from a belt to the frame, and thence to the armature, perforated the insulation so that the machine current had followed it, and burned out the armature coil. The trouble once found, a very simple and effective remedy was employed: Grounded rods were bent from the pulleys so as to take the static discharge from the belt. It is well known that quite a powerful spark can be obtained from belts under certain circumstances, but this is a remarkable instance of its effect.

Electrical Distribution by Transformers from Central and Eccentric Stations.*

BY DR. J. A. FLEMING, M. A.

§ 3. *Ganz Alternator.*—Proceeding, then, more particularly to describe the elements of the system, we take first the alternator, or alternating dynamo. The most recent type of Ganz machine, called the A type, is an alternator of that class in which the fixed or stationary electro-magnetic portion constitutes the armature, and the revolving portion the field magnet. In Fig. 2 is shown a perspective view of the alternator, and in Fig. 3 face and end elevations. The field magnet is a stellate electro-magnet, keyed on the steel shaft, which is the driving shaft. In the smaller sizes this shaft carries the usual pulley for belt or ropes

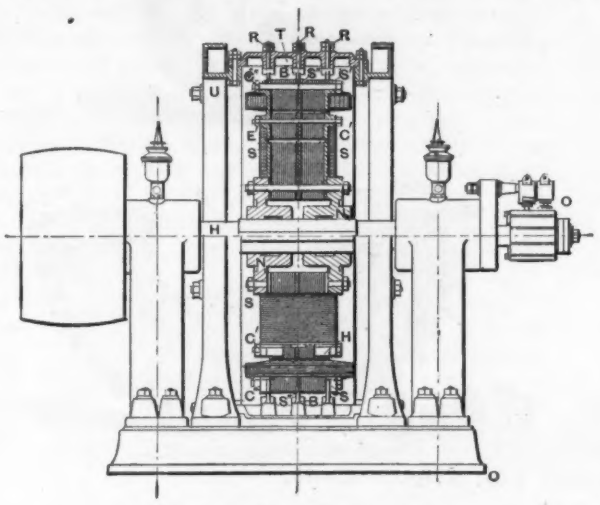


FIG. 3 A.—FACE ELEVATION.

keyed on outside the two massive bearings which are erected upon the bed-plate. A reference to Fig. 3 will also show how this stellate magnet is constructed. A number of V shaped sheet iron stampings (Fig. 4, *a*) are punched out and built up with interposed laminæ of paper into the cores, which are bolted in between two iron hubs or rings keyed into the shaft. These cores project like the stout spokes of a rimless wheel, and over them are slipped the magnet bobbins wound on split zinc frames. The bobbins are kept in position on the cores by a head or cap of gun-metal, which fits on the end of the laminated magnet core, and is firmly secured to it by a traversing bolt.

The magnet poles are even in number, varying from six to 40, according to the size of the machine, and are alternately north and south poles. Surrounding this stellate magnet is the ring-shaped armature frame, formed of two massive iron rings kept apart by distance pieces and bolted together. This armature frame carries on its inner circumference the armature coils. These, like the field-magnets, consist of cores built up of sheet iron stampings, T-shaped (Fig. 4, *c*), which are held together by bronze press plates and by bolts. On to these cores are slipped the armature bobbins, which consist of vulcanized fibre frames, wound over with highly insulated wire. These bobbins are joined up in series in such manner that the currents induced in each are in the same direction, and generally one-half of the armature coils is put in parallel with the other half, the individual coils in each half being joined in series. In like manner the several magnets of the field magnet are divided into two sets, the magnet coils in each set being in series, and the two sets being joined up in parallel. The clearance between the polar faces of the field magnets and the armature magnets is very small. Each armature section is thus complete in itself, and can be removed or replaced in a few minutes. The armature sections are screwed to distance-pieces of the main ring frame, but insulated from them by intervening insulating pieces. In building up the stellate electro-magnet core one layer of the V-shaped iron stampings is first arranged in the proper angular positions; another layer is then laid over them, with paper between, but so that the individual stampings of the second layer

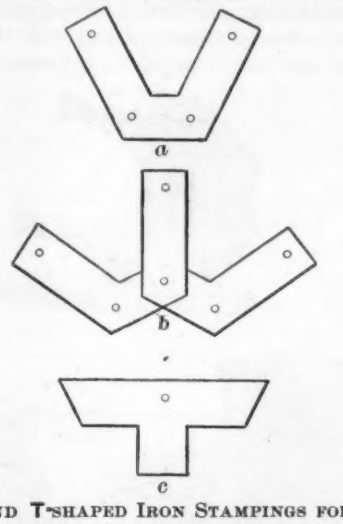


FIG. 4.—V AND T-SHAPED IRON STAMPINGS FOR BUILDING UP FIELD-MAGNET AND ARMATURE CORES.

"break-joint" with those of the first, and the process continued until the proper thickness is obtained (see Fig. 4, *b*). Strong iron press plates are then bolted up so as to compress all this mass of laminated iron into a star-shaped magnet. The bobbins having been put on the cores, the slightly projecting ends of the cores are fitted with bronze bobbin holders, held on by a bolt which traverses the laminated pole, in order to prevent the bobbins from being thrown off when the magnet revolves.

In some of the larger sizes of machines the annular armature frame is made to slide along the bed plate in guide slots by means of a screw. By this means the whole armature can be moved along laterally, so as to move it off the field magnet, and enable this latter to be got at easily for repairs. The machines are made either to be auto-excited or separately excited. In the former case the excitation of the field magnets is effected by a rectified alternating current. This current is supplied from the secondary circuit of a subsidiary transformer, whose primary is fed from the armature. The alternating current is rectified by means of a commutator keyed upon the shaft of the dynamo. This commutator is made in the following fashion: On an insulating hub are arranged brass or copper cylindric sections, as many in number as the poles of the stellate field magnets. These metal segments are insulated from each other and separated by narrower metal sections insulated on both sides from the main sections (see Fig. 5, in which the thick black lines represent the insulating portions—mica). The narrower sections are all connected together, and the wider sections are also so connected that alternate large sections are in conducting contact.

In Fig. 6 we imagine the cylindrical surface of the commutator rolled out flat, the connections between the segments being represented by the firm and dotted lines. The brushes are represented diagrammatically in an oblique position. On opposite sides of the commutator there are two pairs of brushes, one brush at each side being a little in advance of its fellow. One set of the wide sectors, of which a member may be supposed to be in contact with one brush, is connected to the extremities of the field-magnet circuit; and the alternate sectors, one member of which is in contact with a brush on the opposite side of the commutator, are in connection with the other end of the field-magnet circuit. The alternating exciting current enters by one brush and passes through the field-magnet coils. As the electromotive force of the field transformer falls to zero and then reverses sign, so the sectors pass under the brushes, reversing the connection with the ends of the field-magnet circuit, and hence preserving the current through the field magnets always in the same direction. The use of the second brush on each side in advance of its fellow, and also of the intermediate sectors on the commutator, is to prevent the spark at the instant when the brushes change

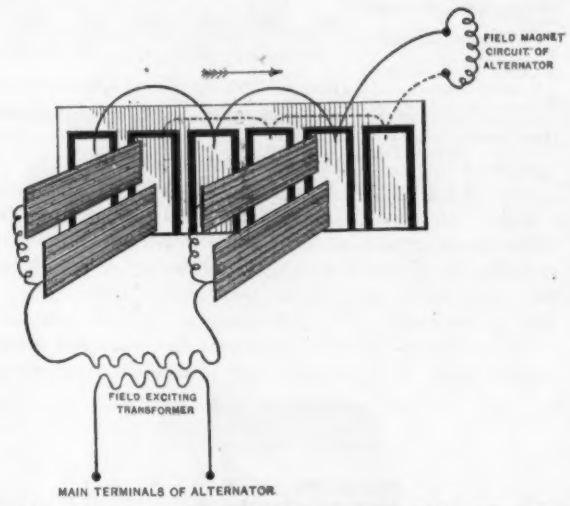


FIG. 6.—DIAGRAM REPRESENTING ACTION OF COMMUTATOR.

sectors; and this is achieved by connecting through a little resistance the brushes on the same side of the commutator, one being a little in advance of the other, by an amount sufficient to place the one brush on the intermediate or neutral sector at the instant when its fellow steps off the "live" sector just behind it. At the instant, then, before the change of connection is made by the brushes leaving their respective sectors they are short-circuited by reason of the fact that their companion brushes are on the intermediate sectors, which are all in conducting connection. Hence the sparking, which would otherwise exist, due to the self-induction of the field-magnet circuit, is kept under, and the wear of the commutator greatly improved. This same device of a pair of brushes, one having a lead over the other to stop sparking, is employed in the Ganz alternating motor. (*Lon. Electrician*, Vol. XXIV., p. 453, 1890.) The larger sizes of the Ganz alternators are not self-exciting, but are excited by a continuous current from a separate exciting dynamo. In the smaller sizes (150 h. p.) of central station alternators the magnetizing current is conveyed into the alternator by means of copper contact rings and brushes pressing against them. In the larger sizes of central station alternators (600 h. p.) the exciting current is conveyed into the alternator by a pair of flexible copper ropes, weighted at one end, and hanging over deeply-grooved brass pulleys insulated from but carried on, the main shaft, and which are respectively the terminals of the field-magnet circuit.

In all these machines the magnets are so designed that at

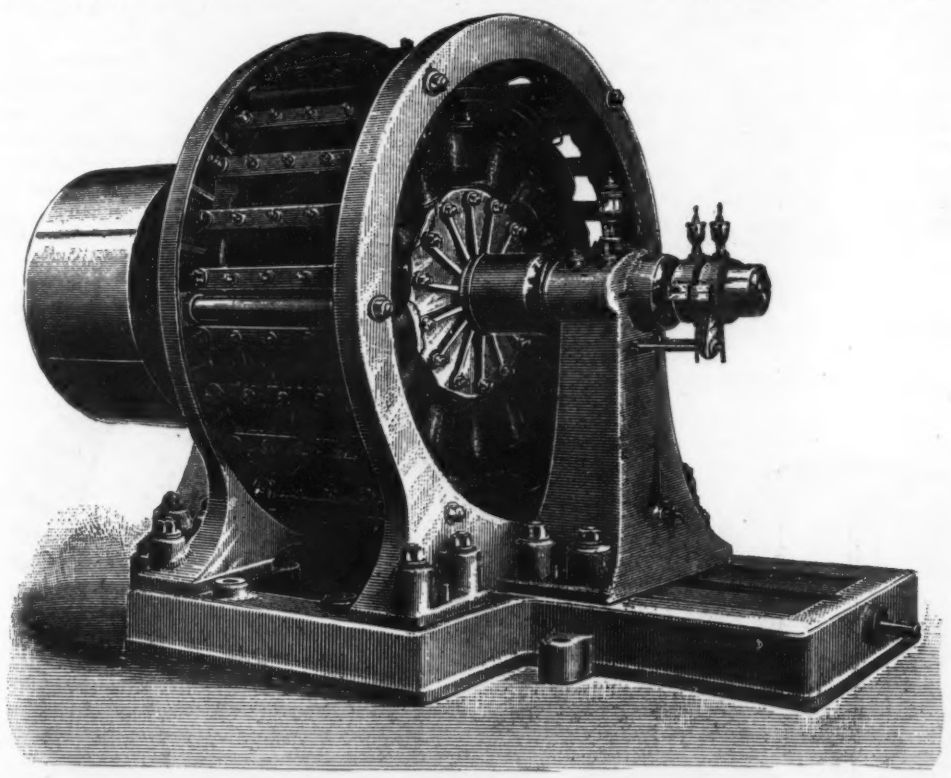


FIG. 2.—GANZ ALTERNATOR (ZIPERNOWSKI, DERI, BLATHY) 50 KILOWATT.

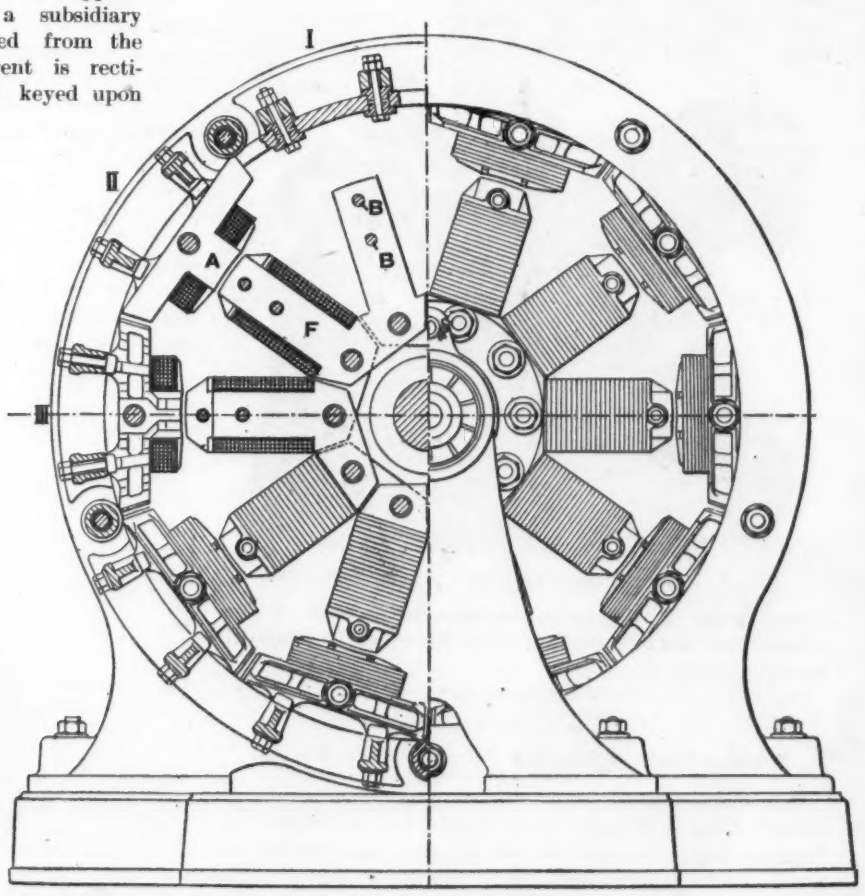


FIG. 3.—END ELEVATION.

* See THE ELECTRICAL WORLD, July 26, 1890, p. 58.

normal speed they produce a current having 5,000 reversals per minute, or about 83 per second, or a "frequency" of 42 per second, that is to say, the current has 42 complete periods per second.

The alternators are made in about eight sizes, varying in output from 10,000 to 380,000 watts, as shown in the following table:

GANZ ALTERNATORS.—TYPE A.

Number.	1.	2.	3.	5.	6.	7.	8.
Maximum output of dynamo in watts	10,000	20,000	30,000	50,000	80,000	160,000	380,000
E. M. F. at terminals in volts	1,000	2,000	2,000	2,000	85,000	5,000	5,000
Revolutions per minute	830	830	625	500	360	170	125
No. of poles on field-magnet	6	6	8	10	14	30	4
Weight of machine in kilograms	700	1,100	1,700	3,400	6,100	11,000	23,000
Maximum output of dynamo in watts	9,650	19,300	28,950	48,250	77,200	154,400	366,000
Horse-power required to drive dynamo at full load	15.6	29.8	44.1	76	120	233	550

The values here given for output and absorbed power are taken from catalogue figures, and must not, therefore, be regarded as having the weight and accuracy which might be expected from careful independent tests. They are here given merely for the purposes of general comparison.

The exciting dynamos employed in connection with the larger sizes of machines are ordinary drum-armature

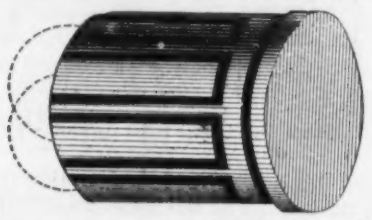


Fig. 5.—Commutator for Rectifying Alternating Currents.

shunt dynamos supplying current at about 100 volts. The field magnets are of the well-known form of vertical single horse-shoe type, and are illustrated in Fig. 7, and call for no special remarks. In some cases of central-station work the exciters are direct-driven by coupled engines, and in other cases they are driven by a belt off the alternator shaft. The general practice is to cause two or three alternators to feed into a pair of mains which supply the field magnet circuits of the alternators arranged in parallel

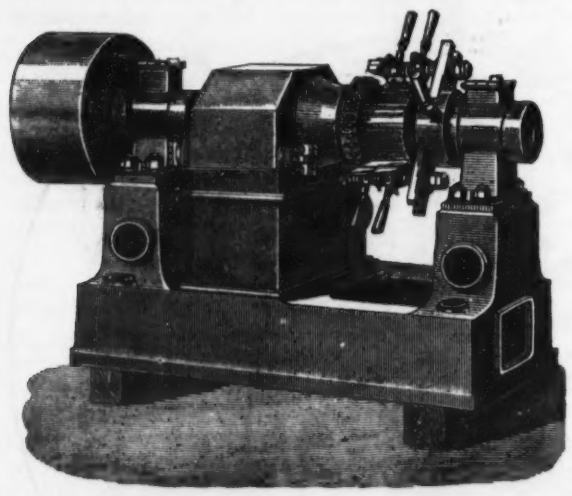


Fig. 7.—Continuous-Current Exciter Dynamo.

across them. By this arrangement a breakdown of one exciter does not interrupt the maintenance of the fields of the alternators.

(To be Continued.)

Wooden-Toothed Gearing for Street-Car Motors.

One of the most important points in the application of electrical power to street-car propulsion is the problem of transmitting the power from the armature shaft to the car axle. In the earlier experiments, both abroad and in this country, belts of leather and rope were used, and also the sprocket wheel and chain. These methods have been almost entirely given up, and some system of gearing is now very generally adopted. Owing to the high speed of the armature, it is customary to use a small pinion, and at least one counter-shaft between the armature and the large gear on the axle, in order to get the desired reduction in the number of revolutions of the car wheel. Supposing the car wheel and axle to be making 115 revolutions per minute, the intermediate 345 and the armature pinion 1,380, which would represent a ratio of 12 to 1, the axle gear containing 50 teeth would make $115 \times 50 = 5{,}750$ meshes of teeth per minute for axle gear and intermediate pinion. The small diameter of pinion will not allow more than 17 teeth, which are usually less than 4-inch face. In ordinary mill practice this pinion would be considered entirely too small to transmit 5 h. p. or even 10 h. p. for any considerable length of time running above 800 revolutions.

It is well known that, with the adoption of the ordinary form of gearing, certain difficulties have arisen in the way of noise and wear, which heretofore it has been impossible to overcome. To meet these difficulties an interchangeable elastic gear, which is illustrated on this page, has been constructed, which seems to obviate many of the troubles met with in the use of the older gears. The gears here described and illustrated are manufactured by Messrs. Chadbourne, Hazleton & Co., Philadelphia, Pa.

The old form of gear, when new and first started on the car, seemed to give good satisfaction with pinions made of either cast iron or steel. After running a few weeks, however, so much wear comes upon the pinions, which have to do about four times the work of the gears, that they become badly worn and somewhat noisy. There is also considerable twisting of the motor in stopping and starting which tends to throw the shafts out of alignment, which often results in wedging the teeth apart and breaking or nipping them out.

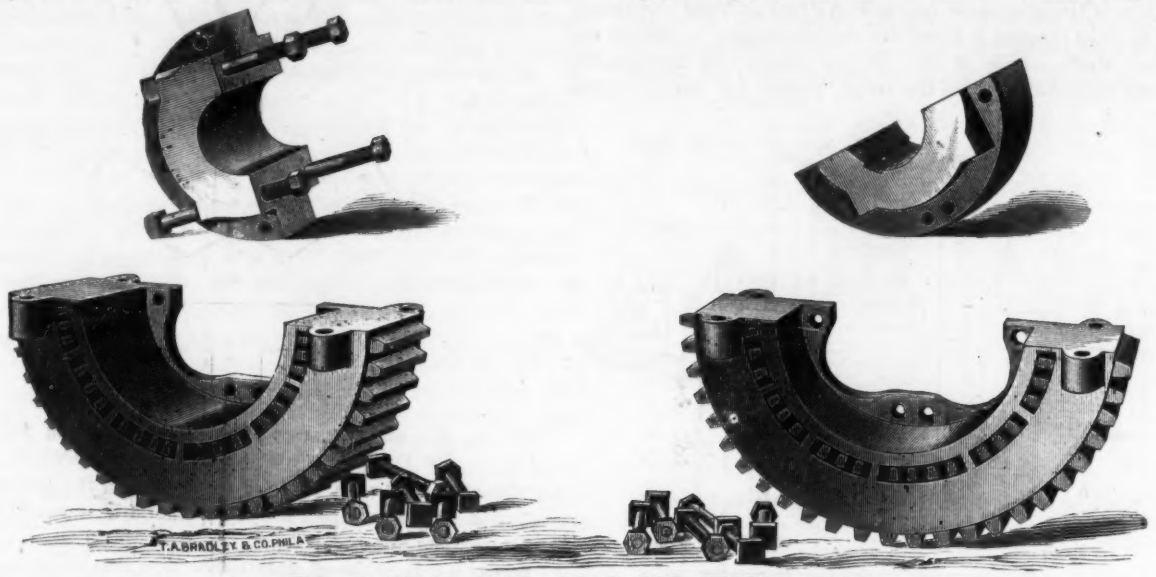


Fig. 2.—Split Axle Gear for Street Cars.

An effort was made to overcome the noise of the metal pinion running on a metal gear by substituting some soft material for the pinion. Raw hide, vulcanized fibre and combinations of raw hide and metal have been tried, but it is contrary to the general practice of the present day to run a soft pinion on a hard gear, since the pinion must necessarily do several times as much work as the gear on which it runs.

The method of construction of the improved type of gears referred to above will be readily understood by reference to the illustrations. The intermediate gears, as will be seen in Fig. 1, are made up of three separate parts; the blank or hub which is keyed fast to the axle, the removable rim that holds the cogs, which is bolted to the hub, and the wooden teeth which are inserted in the rim. It might seem that the wooden teeth would scarcely stand the strain and wear which is brought upon them in street car service, but in New England, where the largest mills are driven by turbine wheels, and where thousands of horse power are used in a single mill, this entire power is transmitted through bevel gearing, the larger gear always having wooden cogs, for the reason that nothing else has yet been found that would stand the work. These cogs last several years, and then are renewed at a slight expense, as they are simply driven in the iron frame of the wheel. They also have the advantage of being elastic and noiseless. The teeth which are used in the gear shown in Fig. 1 are of selected wood, and are driven in with white lead, and wedged at the base in the usual way. They are then put into the gear cutter and cut in the ordinary manner. The rim is made of a specially fine grade of cast iron and slips over the blank, being held in place by six bolts. Between the rim and the hub is laid a sheet of oil paper, which prevents any corrosion, and also stops any vibration or "bell tone" from the gear.

The blank is keyed firmly to the intermediate shaft, and need never be removed. After the wooden teeth have become entirely worn out, all that is necessary is to remove the six bolts and slide off the rim; an extra rim with the teeth in it can then be put on, the entire change not occupying over ten or fifteen minutes. Any ordinary carpenter or wheelright can then recog the old rim and cut the teeth in a half day's time, so that the expense of replacing the cogs is merely nominal, and there is no danger of the gear giving way at a critical moment, causing delays, annoyance and loss. This intermediate gear is guaranteed against wear or breakage for two years, and as no part of this wheel comes in contact with the pinion, there seems to be no reason why it should not last ten years. The wooden cogs are guaranteed against wear or breakage for six months.

The armature pinion which is supplied for running in this gear is made of forged steel with the teeth case hardened after being cut.

The pinion on the intermediate gear is also made of forged steel with case-hardened teeth. Little trouble has been caused by the intermediate pinion, and it is thought that it will last about one year, provided it runs in the wooden cogged, split gear.

The split gear on the axle is, of course, the one which will wear the longest as it makes the fewest revolutions. Yet there have been many instances of the old iron or steel split gear breaking in going down hill, sometimes causing expensive injury to the motor, sometimes flying and breaking off the side bracket of the motor. In order to obviate this danger and overcome the noise of the motor gear, a split gear is used having a rim similar to the intermediate gear in which are driven wooden teeth. This gives a practically noiseless set of gearing. The split gear shown in Fig. 2 is composed of two parts, the blank or hub which is split and put on the axle, and the rim which is also split and put on so as to break joints with the hub. This split gear is guaranteed for two years against wear or breakage, and it is believed that under ordinary circumstances it will wear ten years; the wooden teeth are also guaranteed for one year.

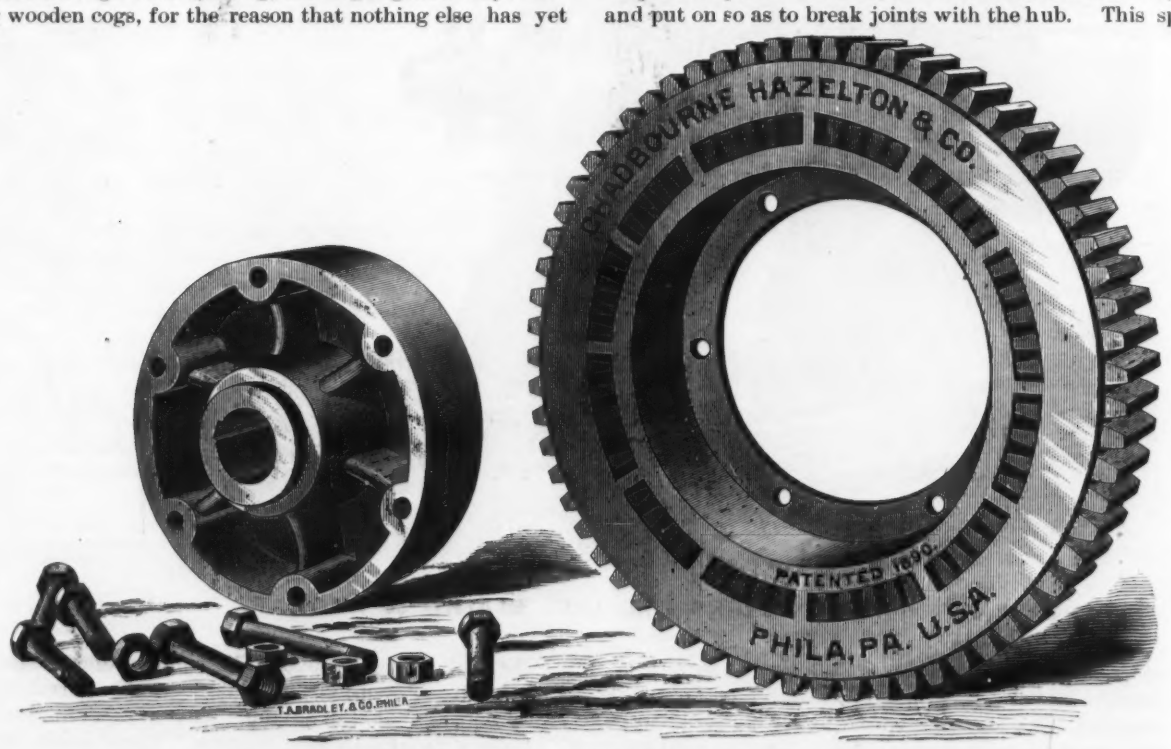


Fig. 1.—Intermediate Gear Showing Hub Removed.

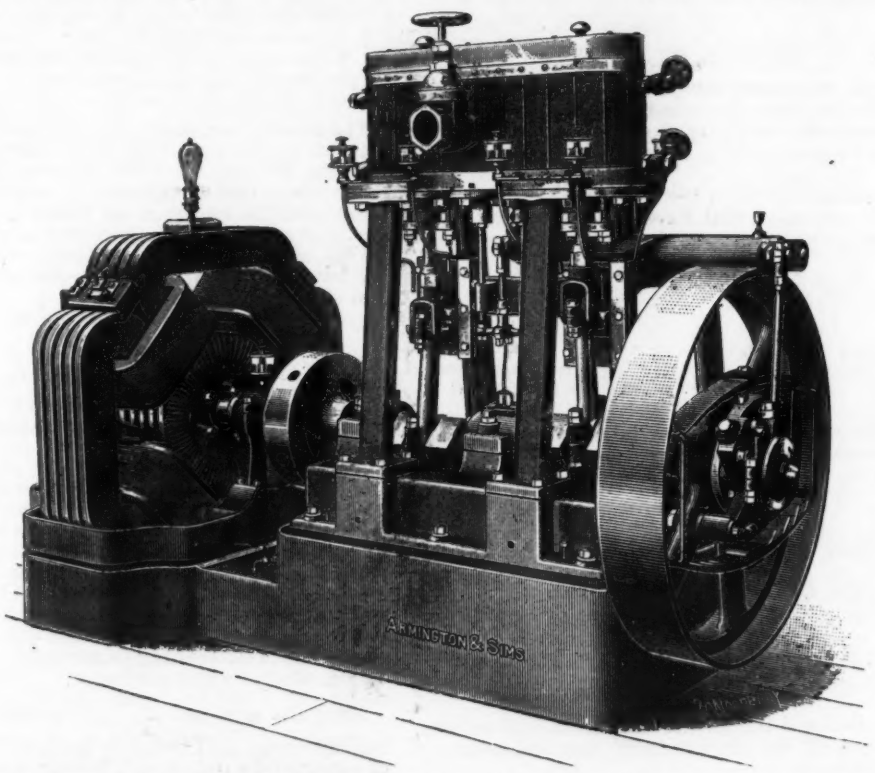
The Pennsylvania Railroad Company, operating an extensive electric railway in Atlantic City, has discarded all its old gears and adopted this style of gearing. These gears have also been adopted by the Wilmington City Electric Railway and the South Side Land Improvement Company, of Richmond, Va., and others.

The advantage claimed for mortised wheels with wooden cogs over other forms of gearing for electric cars is the fact that the wear is concentrated upon the wooden cogs, the renewals of which are trifling.

A Marine Lighting Plant for the "Vesuvius."

The peculiar conditions under which electric light plants are installed on shipboard, especially in the naval service, have made necessary, in many cases, the construction of a specially designed plant adapted in weight, size, speed and other details to the requirements of the ship for which it is intended. Some years ago a small plant, consisting of an Armington & Sims vertical engine and a Thomson-Houston four-pole 4,000-watt dynamo, coupled direct, were constructed for the United States naval service. This plant has been in use some time at one of the government torpedo stations, and is now about to be put on board of the "Dolphin" to replace a plant that has been in use for about six years.

The accompanying illustration shows another plant of about the same size and general character but possessing some important modifications which has been constructed and delivered to the government to operate incandescent lights and a search light on board the dynamite cruiser "Vesuvius." Both engine and dynamo are mounted upon a common base plate and are coupled together direct through a flexible Brotherhood coupling, as shown in the cut. The engine is of the Armington & Sims type, direct acting, with two 5 × 7 vertical cylinders. The crank pins are 180 degrees apart. The springs of the fly-wheel governor are clearly shown in the cut. The engine is intended for use with an initial steam pressure of 60 to 70 pounds, but as the ship's steam is considerably higher than this, it will be necessary to use a reducing valve. It is built to cut off between one-third and one-fourth stroke, and to exhaust either into the air or into a vacuum. The latest and most improved lubricating



ELECTRIC LIGHT PLANT FOR THE DYNAMITE CRUISER "VESUVIUS."

cups are fitted to all journals, both moving and stationary: oil guards are provided, and the oil-tight base receives the drip, from which it can be drawn off by a suitable cock. The shaft has three bearings, one between the cranks and one on either side, and is built to run at a speed of 500 revolutions per minute.

The dynamo, which is mounted on the same base, is a Thomson-Houston compound-wound, constant potential generator having a capacity of 50 ampères when generating an electromotive force of 80 volts. It has four poles, the four magnet coils being placed as shown in the cut. Within the magnet coils the iron of the magnetic circuit is not laminated as it is between the coils. The armature is of the Gramme ring type, and, being directly coupled with the engine, makes 500 revolutions per minute when the dynamo is generating its maximum output. The dynamo is both magnetically and electrically insulated from the base by hard rubber bushings and washers about the bolts which hold it in place, and by air space. The insulation from the engine is secured by the leather cushion of the flexible coupling.

The plant was built in accordance with accurate and detailed specifications furnished by the Navy Department. The dynamo must have, according to the requirements, not less than 80 per cent. commercial efficiency, and must not be heated more than 60 degrees Fahr. above the surrounding atmosphere after a run of four hours at full load. A variation of only one and a half per cent. from the normal speed of 500 revolutions is allowed to produce the maximum output. In regard to weight, the specifications provided that it should not exceed one pound for every three watts output. The collector is made of hard copper, insulated with mica, with bars 1⅛ inches deep.

The regulation of the engine speed is required to be not more than 2 per cent. when the load is varied from full load to 20 per cent. of the total or when the steam pressure fluctuates from 60 to 100 pounds while exhausting into the atmosphere. A variation of 5 per cent. is allowed in the speed between no load and the maximum, or when exhausting either into the air or a vacuum with the steam pressure at about 60 pounds. The tests which have been made of the engine have shown that these requirements have been fully met. The dynamo has not yet been tested by the government engineers. The weight of the entire plant was limited by the specifications to 3,000 pounds, or about three-fourths of a pound per watt when working at the maximum output. It was also specified that no part should be larger than 90 × 29 inches, this being necessary because of the size of the hatchway on board the "Vesuvius," through which the machinery must pass. The striking features of this really beautiful plant are the lightness and compactness of the engine and dynamo.

The contract for the entire lighting plant was given to the Thomson-Houston Electric Company and the installation of the wires and fixtures is now being made. The two-wire, metallic-return system is used, all wires being lead-covered and placed in wooden molding. When finished the entire installation will be subjected to a thorough test to ascertain if the specifications as to insulation, resistance, efficiency, etc., have been carefully carried out.

The Application of the Law of Economy to Electrical Conductors.

BY GEORGES SANTARELLI.

We shall have $m + n$ unknown quantities connected by only n equations; there being no other conditions imposed, we can deduce m equations, which are lacking the condition of economy, $\Sigma\, l\, d^2 =$ minimum, extending the summation to the whole network. The n equations deduced from Ohm's law for each branch would be the following:

$$\begin{aligned} E_1 - \varepsilon_1 &= i_1\, c\, \frac{l_1}{d_1^{\,2}} \\ &\cdots\cdots\cdots\cdots \\ &\cdots\cdots\cdots\cdots \\ \varepsilon_2 - \varepsilon_n &= i\ \ c\, \frac{l}{d_1^{\,2}} \end{aligned} \qquad \text{(A)}$$

Using now the method employed in the differential calculus for obtaining values which render a function of several variables united by several equations of condition a maximum, we may form the function $U = V + \alpha\,\varphi_1 + \beta\,\varphi_1 + \ldots$; where V is the function to be made a minimum, $\varphi_1 = 0$, $\varphi_2 = 0$, are the equations of condition (A), α, β, γ being the unknown auxiliary quantities. Equating to zero $(m + n)$ partial derivatives of m to the variables d_1, d_2, ε_1, ε_2, ε_3, ... we shall have another system of $(m + n)$ equations, which, with the n given equations of the first system (A), will enable us to eliminate the coefficients α, β, γ, and to determine the values of $d_1, d_2, \ldots d_n, e_1, e_2, e_3, \ldots e_m$.

We have then

$$U = \Sigma\, l\, d^2 + \alpha\,(E_1 - e_1 - i_1\, c\, \frac{l_1}{d_1^{\,2}} + \ldots .$$

$$\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$

$$+ \lambda\left(e_2 - e_n - i_r\, c\, \frac{l_r}{d_r}\right) + \ldots .$$

from which we may deduce the systems

(B) n equations

$$\frac{d\,U}{d\,d_1} = 0 \quad \cdots\cdots \quad \frac{d\,U}{d\,d_n} = 0$$

(C) m equations

$$\frac{d\,U}{d\,\varepsilon_1} = 0 \quad \cdots\cdots \quad \frac{d\,U}{d\,\varepsilon_m} = 0$$

Any one of the equations of the system (B), if μ is the unknown auxiliary quantity belonging to a branch of diameter d, takes the form $2\,l\,d + 2\,\mu\,i\,c\,\frac{l}{d^3} = 0$ or $\frac{d^4}{i} = -\,c\,\mu$. In all these equations c is constant but i, d, μ vary from one equation to another. As to the m equations of the system (C) it is evident that each one of these is obtained by putting equal to zero the algebraic sum of the terms formed from the single unknown auxiliary quantities of the first degree. We see these auxiliary quantities enter into each of the equations (C) corresponding to one of the nodes of the network (*e. g.*, r^{th}), since the terms of the r^{th} equation (C) arise from the derivative of μ with respect to ε_r (and ε_r appears in the expression containing μ only in the terms relating to the branches of the network which meet at that particular node), it is clear that the r^{th} equation will contain the algebraic sum of the unknown quantities which pertain to these branches and not to any others.

As to the sign which should be given to α, for example, in the equation, we see that it will be positive if ε_r is greater than the potential at the opposite extremity of the line to which α corresponds, negative if ε_r is smaller. If α, β, γ δ are the auxiliary quantities, and if we suppose that $E_1 > \varepsilon_r$, $E_2 > \varepsilon_r$, $E_3 > \varepsilon_r$, $E_4 > \varepsilon_r$, we shall have $-\alpha - \beta + \gamma + \delta = 0$. (M)

On the other hand, the equations of the system B corresponding to the conductors in question give us

$$\frac{d_1^{\,4}}{i_1} = -\,c\,\alpha \qquad \frac{d_3^{\,4}}{i_3} = -\,c\,\gamma$$

$$\frac{d_2^{\,4}}{i_2} = -\,c\,\beta \qquad \frac{d_4^{\,4}}{i_4} = -\,c\,\delta$$

If we add the two first equations member for member and subtract from them the two others we shall have

$$\frac{d_1^{\,4}}{i_1} + \frac{d_2^{\,4}}{i_2} - \frac{d_3^{\,4}}{i_3} - \frac{d_4^{\,4}}{i_4} = c\,(-\alpha - \beta + \gamma + \delta) \qquad \text{(N)}$$

but the quantity in the parentheses becomes zero from the equation (M). Observe now that on the hypothesis made on the values of E with respect to ε_r, the currents in the branches 1 and 2 are toward the node on the construction, while they leave it by branches 3 and 4. If then we systematically give the positive sign to all currents which leave a node and the negative sign to all currents flowing toward the node, the equation (N) can be written in a very simple form, $\Sigma\frac{d^4}{i} = 0$ (S) where the summation is extended to all the branches which compose the node considered. In the same way for each of the m nodes we should have a new system of m equations analogous to (S), for which the auxiliaries are already eliminated. Combined with the n equations of the system (A) they enable us to determine the values of the diameters and the potentials at the nodes which specify the conditions of maximum economy.

The general principle then can be enunciated as follows:

In any network of conductors traversed by given currents Q, and having at the extremity of the network known potentials, the values of the diameters which give the lowest expense of installation, are those which specify at the same time Ohm's law applied to each branch of the equation $\Sigma\frac{d^4}{i} = 0$ *applied to each point where two or more conductors meet.*

By a somewhat different process we may find for hydraulic conduits an expression of analogous form where the diameters of the tubes enter to the sixth power and the current to the second power.

Let us apply these principles to the most interesting of the cases which we shall meet in practice.

CASE I.—Take for example a conductor supplied with current by dynamo D (Fig. 3). Let E be the figure of the potential with dynamo, e minimum potential of the extremity of the line. Let i_1 be the current in the first segment of wire of the length l, at the extremity of which a current of a given amount is led off. The current in the principal conductor for length l_2 having an intensity i_2.

Put $\Delta E = E - \varepsilon$, the total given value of potential, and let us find the distribution of ΔE in the two parts $\Delta\varepsilon_1$, $\Delta\varepsilon_2$, which will give the greatest economy in conductors. Here is a single node with two branches: then

$$\frac{d_1^{\,4}}{i_1} - \frac{d_2^{\,4}}{i_2} = 0 \qquad (1)$$

join this equation to the others:

$$\Delta e_1 + \Delta e_2 = \Delta E \qquad (2)$$

$$\Delta e_1 = i_1 c\,\frac{l_1}{d_1^{\,2}} \qquad (3)$$

$$\Delta e_2 = i_2 c\,\frac{l_2}{d_2^{\,2}} \qquad (4)$$

In this case the solution is susceptible of a quite similar and a brief expression. Indeed, we obtain from (1) $\frac{d_1^{\,2}}{d_2^{\,2}} = \sqrt{\frac{i_1}{i_2}}$, that is to say, the sections of the conductor will be proportional to the second roots of the currents providing member for member the equations (3) and (4), and taking account of this last relation established, we have

$$\frac{\Delta\, e_1}{\Delta\, e_2} = \frac{l_1\sqrt{i_1}}{l_2\sqrt{i_2}} \qquad (5)$$

which with (2) gives us

$$\Delta\, e_1 = \frac{\Delta\, E}{1 + \frac{l_2\sqrt{i_2}}{l_1\sqrt{i_1}}} \qquad \Delta\, e_2 = \frac{\Delta\, E}{1 + \frac{l_1\sqrt{i_1}}{l_2\sqrt{i_2}}}$$

Hence we can easily deduce the diameters from the equetions (3) and (4). We thus see that equation (5), reduced to the form

$$\frac{\frac{\Delta\, e_1}{l_1}}{\frac{\Delta\, e_1}{l_2}} = \sqrt{\frac{i_1}{i_2}}$$

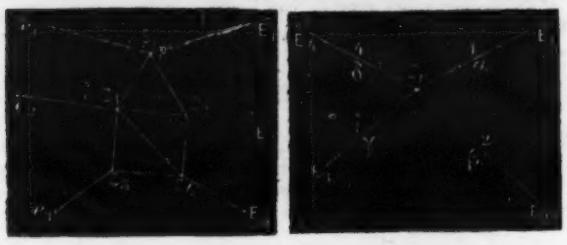
shows us that the laws of potential, with respect to unit of length in the two branches, are to each other as the square roots of the currents.

Case 2—Main with two or more branches distributed along it. Let there be the system of conductors represented below (Fig. 4). With a network of this kind the direct algebraic solution of the problem such as was obtained in the first case cannot be found. It leads to so complicated developments of the formulæ that the simple calculation by substituting the numerical values of the algebraic symbols becomes interminable. Besides this the expressions of the diameters and potentials at the nodes as functions of the known quantities vary from one case to another, so that one cannot obtain the final expressions in a form sufficiently general and always applicable, and it is useless to find any particular algebraical solutions. But the method which can always be applied in this case, and which for the necessary rapidity of the calculations in cases of this kind is specially useful, is the method of solu-

tion by successive approximations. If one proceeds by a regular course only, no more than two approximations are generally necessary. To indicate in detail the method to be followed, and to show effectively the convenience of the formulæ, I shall give an example which frequently appears in practice. The arrangement of the circuit is shown in Fig. 5. Let $E = 107$ volts be the potential of the dynamo, $e = 90$ volts the potential at the extremity of the network. Let us suppose that the lengths of the current intensities in the various branches are as follows:

Branch.	l	i
1	140 mèters	27 ampères
2	354 "	9 "
3	200 "	18 "
4	464 "	9 "
5	310 "	9 "

If l is expressed in metres, d in millimetres, we have



FIGS. 1 AND 2.

for copper of the ordinary conductivity the coefficient $c = .0212$ in the formula $R = c\frac{l}{d^2}$; then for the first branch Ohm's law gives $107 - e_1 = 27 \times 0{,}0212 \times 140 \times \frac{1}{d_1^2}$

For the others we can found a system of equation is

$$107 - e_1 = \frac{80.1}{d_1^2} \quad (1) \qquad e_1 - e_2 = \frac{76.2}{d_2^2} \quad (3)$$

$$e_1 - 90 = \frac{67.6}{d_3^2} \quad (2) \qquad e_2 - 90 = \frac{88.5}{d_4^2} \quad (4)$$

$$e_2 - 90 = \frac{59.1}{d_5^2} \quad (5)$$

The two equations which we lack to determine the seven unknown quantitities, $d_1 \ldots d_5$, e_1, e_2, are given by the condition of economy applied to the two nodes, that is:

$$\frac{d_1^4}{27} = \frac{d_2^4}{9} + \frac{d_3^4}{18} \quad (6)$$

$$\frac{d_3^4}{18} = \frac{d_4^4}{9} + \frac{d_5^4}{9} \quad (7)$$

Begin by taking for e_1 an arbitrary value, intermediate between 107 and 90—for example 102—and see in the subsequent developments how the different quantities vary for increase of 1 in the value of e. Let us express in parentheses after our result the corresponding variation. From equations 1 and 2 when $e = 102$ ($\times$ 1), we have

$$d_1^2 = 16.0\ (+\ 4)$$
$$d_2^2 = 5.62\ (-\!-\!-\ 0.43)$$

Equation (6) gives

$$d_3^4 = 18\left(\frac{d_1^4}{27} - \frac{d_2^4}{9}\right) = 107.4\ (+\ 104.6)\ d_3^2 =$$
$$10.7\ (+\ 3.85).$$

From (3) we may deduce

$$e_2 = 94.87\ (+\ 2.88).$$

Substituting e_2 in (4) and (5), we have

$$d_4^2 = 18.2\ (-\ 6.8)$$
$$d_5^2 = 12.2\ (-\ 4.75).$$

If we transpose in (7) these values of d_3, d_4, d_5, after having transposed to the first number of this equation the two terms of the second number, instead of having $\Phi = 0$, we find

$$\Phi = -\ 48.04\ (+\ 38.10).$$

If now we suppose that the variation of Φ with respect to e_1 is approximately lineal, we shall find by a simple proportion that to obtain $\Phi = 0$, an increase of 1.26 volts for e_1 will be necessary. Let us try this again further with $e_1 = 103.26$ volts. The terms are entered, the equations of the preceding system have already been calculated,

FIG. 3.

consequently the second trial will be more rapid. We find

$$d_1^2 = 21.5$$
$$d_2^2 = 5.09$$
$$d_3^2 = 16.07$$
$$d_4^2 = 10.4$$
$$d_5^2 = 6.95$$

From this we find that the cross sections of the wires by dividing by 1.273. With these values we find $\Phi = -\ 3.13$, instead of $\Phi = O$.

We can regard these approximations as sufficiently exact, remembering that in the vicinity of the minimum the function $\Sigma\, l d^2$ changes very slightly for a small variation of e_1. We calculate the section of areas and find easily that the resulting current densities are within reasonable limits. A simple proceeding can be followed in any case where there is more than one node and where there are two or more branches.

Case 3.—Calculations of the diameters of the successive segments of the principal conductor. It is necessary to investigate the dimensions of a conductor leading from a dynamo of electromotive force equal to E and subject to the condition that there should be throughout its entire length a total loss of potential equal to $\triangle E$.

Let i_1 be the intensity of the current in the first segment of the conductor, i_2 in the second and i_n in the last. Neglecting the loss of potential in the secondary branches we can apply to the first node the formula of economy and put

$$\frac{d_1^4}{i_1} = \frac{d_2^4}{i_2}$$

also for the second node

$$\frac{d_2^4}{i_2} = \frac{d_3^4}{i_3}, \text{ etc.;}$$

consequently

$$\frac{d_1^4}{i_1} = \frac{d_2^4}{i_2} = \ldots = \frac{d_n^4}{i_n} \quad (1)$$

When the segments are n in number, the potentials at their extremities will be $n + 1$ distinct values; that is to say, E being given, $E_1 E_2 E_n$ are unknown and E_n is known by the equation $E_n = E - \triangle E$.

We may now put

$$E_n - E_1 = i_1 c \frac{l_1}{d_1^2}$$
$$\ldots\ldots\ldots \quad (2)$$
$$E_n - {}_1 - E_n = i_n c \frac{l_n}{d_n^2}$$

Dividing member by member the two first of these equations we shall have

$$\frac{E - E_1}{E_1 - E_2} = \frac{i_1 l_1 d_1^2}{i_2 l_2 d_2^2}$$

and substituting with respect to the intensities the fourth powers of the diameters we obtain

$$\frac{l_1 d_2^2}{E - E_1} = \frac{l_2 d_2^2}{E_1 - E_2}$$

A similar proportion can be deduced by the comparison of the following equations of system (2), thus.

$$\frac{l_1 d_1^2}{E - E_1} = \frac{l_2 d_2^2}{E_1 - E_2} = \ldots\ldots = \frac{l_n d_n^2}{E_n - {}_1 - E_n}$$

or again

$$\frac{l_1}{E - E_1}\sqrt{i_1} = \frac{l_2}{E_1 - E_2}\sqrt{i_2} = \ldots\ldots = \frac{l_n}{E_n - {}_1 - E_n}\sqrt{i_n}$$

But $\frac{E_r - {}_1 - E_r}{l_r}$ represents the loss of potential per running meter in the principal conductor in the segment of order r. We can then conclude that to satisfy the conditions of economy the values of potential per unit length in the successive segments must be to each other as the cross

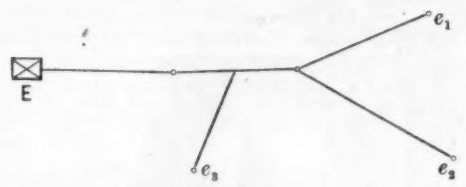


FIG. 4.

sections or as the square roots of the intensities. Starting from the last system found, we have

$$\frac{l_1\sqrt{i_1}}{E - E_1} = \frac{l_1\sqrt{i_1} + l_2\sqrt{i_2} + \ldots + l_n\sqrt{i_n}}{E - E_n}$$

The denominator of the second number is known and equal to $\triangle E$; and $E - E_1 = i_1 c \frac{l_1}{d_1^2}$, so that

$$\frac{l_1\sqrt{i_1}}{i_1 c \frac{d_1^2}{l_1}} = \frac{\Sigma\, l\sqrt{i}}{\triangle E}$$

From this equation and the further analagous ones we can deduce the values of the diameters of the different segments as follows:

$$d_1^2 = \frac{c\,\Sigma\, l\sqrt{i}}{\triangle E}\sqrt{i_1}$$
$$\ldots\ldots\ldots\ldots$$
$$d_n^2 = \frac{c\,\Sigma\, l\sqrt{i}}{\triangle E}\sqrt{i_n}$$

We must notice that the factors by which the radical is multiplied are always the same, consequently the remainder of the calculation is quite rapid when the value of the same, $\Sigma\, l\sqrt{i}$, is once obtained. We see that in this case the limit of application of these formulas is set by the condensation of current density. Let K' be the limiting coefficient, that is to say the maximum ampères that can be allowed per square millimetre of cross section in the diameter employed. For convenience in calculation and to avoid the factor $\frac{\pi}{4}$ let us introduce the factor K' given by $K = 0.785\ K'$.

In any secttion, then, we shall have $i_r \leq K d_r^2$; and since we have found $d_r^2 = \frac{c\,\Sigma\, l\sqrt{i}}{\triangle E}\sqrt{i_r}$ we may conclude that this formulæ can be applied for determining the diameters if $\frac{c K \Sigma\, l\sqrt{i}}{\triangle E} \geq \sqrt{i_r}$ (R)

As the terms with the radical have already been calculated in the investigation of $\Sigma l\sqrt{i}$, they can easily be verified by a simple comparison of the values of $\sqrt{i}$ with the constant term of the first number in the segment to which segment the formula is applicable.

Case 4.—Calculation of a principal conductor with uniform distribution of current throughout its length. Let us consider a conductor of length l in which the value of potential from one end to the other is equal to $\triangle E$. Suppose, then, we must distribute a current i from meter; il will be the current at the dynamo, ix the current at any point whatever of the conductor defined by the length x counted from the opposite extremity to the dynamo. Although such a system may seem strange at first sight, it may be noticed that it can be reduced to those terms which one desires, for example, in lighting uniformly an enclosure with a conductor which runs round it, or again in the employment of a conductor for lighting public parks where lamps are uniformly distributed, and so forth.

If we designate by d_x the diameter at the point of the point of the abscissa x, and if we admit for a moment that the variation of $d_x\, d$ is continuous, we shall find that the quantity which must be made a minimum to obtain the maximum economy is $P = \int_o^l d_x^2\, d\, x$; and since d_x is a function x defined by the variation of potential which we find most convenient, we can see that the problem reduces itself to finding the law of variation of potential along the conductor that satisfies the condition P for a minimum. Neglecting the absolute value of the potential at an arbitrary point, and concerning ourselves only with its variation as it passes from the value o for $x = o$ to the given value $\triangle E$ for $x = l$, we shall find that the intensity

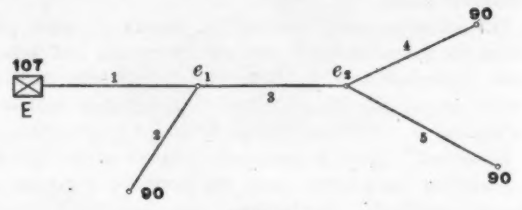


FIG. 5.

$i\,x$ which existed at a given point of the abscissa x in the element of length $d\,x$ has a value of potential expressed by

$$d\,e = i\,x\,c\frac{d\,x}{d_x^2}.$$

When x is counted from the extremity opposite the dynamo we see that $d\,e$ will be the same sign as $d\,x$; hence

$$d_x^2 = \frac{i\,x\,c}{\frac{d\,e}{d\,x}}$$

One can then obtain

$$\int_o^l \frac{i\,x\,c}{\frac{d\,e}{d\,x}}\,d\,x = \text{minimum.}$$

The direct determination of the function $e = f(x)$ which satisfies this condition can be found easily enough by the calculus of variations. We neglect the terms up to the limit (since the variations $d\,e_0$ and $d\,e_1$ are both equal to zero, from the fact that the values of e at the extremities are known). It remains then only to consider the equation which one designates habitually with the symbol $k = o$. We have then a differential equation of the second order and of the second degree:

$$\frac{d}{d\,x}\left(-\,i\,c\,x\,\frac{1}{\left(\frac{d\,e}{d\,x}\right)^2}\right) = o$$

After two successive integrations we can eliminate two arbitratrary consequents and arrive easily at the final value of $e = f(x)$.

Another more rapid process, but perhaps less rigorous, would be to suppose at the start a parabola of the n-th degree along which two variables e and x lie; then, expressing the value of P directly as a function of x, we can equate to zero the derivative of P with respect to n and obtain exponent n, which renders P a minimum. But to preserve a certain uniformity in the deduction of the formulæ we can start always from the principle established in the general problem and treat the actual case as a particular variation of the third case relating to successive segments of finite length of a principal conductor.

From the equation $\Sigma\,\frac{d^4}{i} = o$ applied to each node we can determine that to satisfy the laws of economy the losses of potential for unit length in each main should be to each other as the squares of the diameter, or as to the square roots of the intensities. It is clear that such a law will not be limited by the absolute length of each section; extending the law to the infinitely small elements of length, the loss $\frac{d\,e}{d\,x}$ will be $\frac{d\,e}{d\,x} = \alpha\ \sqrt{i}x = \beta\ d_{x_2}$, represented by α and β two coefficients constantly proportionate throughout the length of the conductor.

By hypothesis the intensity of the current i distributed per unit length is also constant, then $\frac{d\,e}{d\,x} = \alpha\sqrt{x}$. Integrating, we find that the increase of potential between the

FIG. 6.

end of the conductor and the point which is distant from it x will be expressed by $\triangle e = \alpha\frac{2}{3}\alpha x^{\frac{3}{2}} + C$.

The contestants α and C are easily determined by the two conditions that for $x = o$ we should have $\triangle e = o$, and for $x = l$, $\triangle e = \triangle E$.

$$C = o$$

Then $$\triangle E = \alpha\frac{2}{3}l^{\frac{3}{2}}$$

Hence the law of variation of potential which satisfies the law of maximum economy is represented by

$$\triangle e = \frac{\triangle E}{l^{\frac{3}{2}}}\,x^{\frac{3}{2}}$$

If we take for abscissæ the lengths of the conductor starting from the extremity where the potential is lowest and for the ordinates the increments of potential, there will result the parabola of the order $\frac{3}{2}$ convex toward the axis abscissæ and tangent to it at the origin. It then follows that it is best to distribute the greater part of the fall of potential in the segment near to the dynamo where the conductor is charged the highest. From the value of e we may deduce $\frac{d\,e}{d\,x} = \frac{3}{l^{\frac{3}{2}}}\frac{\triangle E}{}\sqrt{x}$; and as we have seen above $\frac{d\,e}{d\,x} = i\,x\,c\frac{1}{d_x^2}$.

We obtain by equating the two members

$$d_x{}^2 = \frac{2}{3}\, i\, c\, \frac{l^{\frac{1}{2}}}{\triangle E}\sqrt{x}. \qquad (A)$$

This equation defines the section at each point of the conductor. It is the equation of a parabola of the second degree with respect to the section. It is interesting to verify the limits set to the application of this formula by considering the intensity of the current. We see that since the segments of the conductor near the dynamo are those which represent the most disadvantageous conditions as to intensity and loss of potential. If the formula is exact here, with proper conditions of density, it will be so throughout the remainder. Let K' be the greatest number of ampères that can be permitted per square millimetre of a section, then putting $K = 0.78\ K'$, as $i\ x$ is the current at a point of the abscissa x for the heating, we shall always have

$$\frac{i\ x}{d_x{}^2} \leqq K \qquad (B)$$

If we substitute here the value obtained for $d_x{}^2$, we see that the values of the diameter given by the formula (A) are applicable only for the final segment of the conductor of length λ; so that $\lambda = \frac{4}{9}\, c^2 K^2 \frac{l^3}{\triangle E^2}$. At every point of the conductor the equation (B) is satisfied, and we notice that the expression is independent of i. And finally, in order that the values given by (A) should be applicable to the entire conductor, we must be able to put $l \leqq \lambda$, that is,

$$\frac{\triangle E}{l} \geqq \tfrac{4}{9}\, c\, K \text{ (C)}.$$

If we express l in metres and d in millimetres, the value of c is 0.0212 for ordinary copper. Then the condition of application becomes $\frac{\triangle E}{l} \geqq 0{,}0141\ K$, in which $\frac{\triangle E}{l}$ represents the mean fall of potential per unit length given by the hypothesis. As the formula (C) is important, being of itself capable of showing whether the calculation can be made according to the law found, I think it useful to insist on the signification of this condition. Let us consider for this the same conductor as above, but let us suppose that the total fall of potential $\triangle E$ is not given in advance. If with the same quantity of this conductor we wish to obtain the maximum return, we can establish the diameters at every point by always working to the maximum density, that is to say, $d_x{}^2 = \frac{i\ x}{K}$

Since we always have $d\ e = i\ x\ d\ r$ and $d\ r = c\ \frac{d\ x}{\frac{i\ x}{K}}$

we shall also have $d\ e = i\ x\ c\ \frac{d\ x}{i\ x} K$. Integrating with respect to x between limits of zero and l, we find

$$\triangle E = c\ K\ l.$$

So the greatest fall of potential which can be obtained with this material, with an identical given current, is $c\ k\ l$; that is, $c\ k$ is the mean loss per unit.

If we compare this result with (C), we note that the distribution of loss of potential, which gives the greatest economy of installation in the case of a diameter for uniform distribution of current throughout its entire length, is that in which the potential decreases following the parabolic law of the order $\frac{2}{3}$.

But this law, by reason of the heating of the conductors, is only applicable if the mean loss of potential per unit length does not exceed two-thirds of the maximum loss which can be borne by the material employed.

Fifth Case.—Most advantageous position for the source of current in the case of two points to be supplied. Let us suppose that at A we must furnish a current i_1 at a potential e_1, and at B a current i_2 at a potential e_2. We have a single dynamo of potential E, and we must find its position so that the cost of the conductors will be a minimum. We have given the distance L between A and B. The equations are—

$$l_1 + l_2 = L$$

$$E - e_1 = i_1\, c\, \frac{l_1}{d_1{}^2}$$

$$E - e_2 = i_2\, c\, \frac{l_2}{d_2{}^2}$$

$$\frac{d_1{}^4}{i_1} = \frac{d_2{}^4}{i_2}$$

From the second and third equations we deduce

$$\frac{E - e_1}{E - e_2} = \frac{i_1}{i_2}\frac{l_1}{l_2}\frac{d_2{}^2}{d_1{}^2}$$

or from the fourth

$$\frac{E - e_1}{E - e_2} = \frac{l_1}{l_2}\sqrt{\frac{i}{i_2}}$$

Taking up the first, we have

$$l_1 = \frac{L}{1 + \frac{E - e_2}{E - e_1}\sqrt{\frac{i_1}{i_2}}}$$

$$l_2 = \frac{L}{1 + \frac{E - e_1}{E - e_2}\sqrt{\frac{i_2}{i_1}}}$$

If we have $e = e_2$, this becomes

$$l_1 = \frac{L\ \sqrt{i_2}}{\sqrt{i_1} + \sqrt{i_2}}$$

$$l_2 = \frac{L\ \sqrt{i_1}}{\sqrt{i_1} + \sqrt{i_2}}$$

I think it is useless to enunciate other problems of this sort because one can imagine an indefinite number of them. It suffices to have treated some of the cases most frequently met with in practice to show that the mathematical expression representing the conditions of a minimum expense of installation can be applied with advantage in many cases where one would be undecided if he did not know the most economical distribution for a given fall of potential.

The Cape May Meeting of the National Electric Light Association.

The twelfth convention of the National Electric Light Association will be held at Cape May, N. J., as has already been announced in our columns, commencing August 19, 1890, and its session will extend over three days.

Cape May offers great advantages for a meeting of this kind; its attractions in summer being on a par with any of the other favorite resorts, and its hotel accommodations unexcelled.

The way for members of the Association to reach Cape May is as follows: By way of the Pennsylvania Railroad from New York city daily except Sunday, leave New York, 11 A. M. and 1,50 P. M., arriving at Cape May at 4.33 P. M. and 6.10 P. M. The price of a round trip ticket good for ten days is $6, and the Pullman car fare, one way, is 75 cents.

By the West Jersey Railroad from Philadelphia daily except Sunday, leave Philadelphia 9 A. M., 2.30 P. M., 4 P. M., arriving at Cape May at 11.15 A. M., 4.33 P. M. and 6.10 P. M. A Sunday train leaves Philadelphia at 8.20 A. M. A round trip ticket good for ten days costs $2, and the Pullman fare one way, is 25 cents.

The secretary of the Association has issued to members a statement of reasons why each one should make an effort to attend this meeting of the convention, among which are the following: (1) If you have any interest in a central station company, either as a stockholder, officer, manager or superintendent, you should attend the convention and there meet those who are similarly interested, in all parts of the United States. Through comparing experiences, taking part in the discussion of questions before the Association, and doing your share to make the meeting profitable to others, it will be sure to be profitable to you. (2) If you are interested in the manufacture or sale of any of the long list of supplies used by the central station men, you can meet more of your customers at this convention in one day than you could in a week of travel. Although there will be no exhibition under the auspices of the Association, you can secure a sample room and display your samples in your own way to the hundreds of users of such supplies who will be at this convention.

The programme for each day will be as follows: Breakfast, from 6 to 10:30; morning session of convention, from 10 to 12; bathing from 12 to 1; dinner, from 2 to 4; afternoon session of convention, from 4 to 7; supper from 7 to 9; orchestral concert or hop, from 9 to 11.

The convention will meet in the large ball-room of the Stockton Hotel, capable of seating 800. This room has been placed at the disposal of the association by the proprietor without charge. Letters to engage rooms should be addressed to F. Theo. Walton, proprietor, Stockton Hotel, Cape May, N. J.

The following special table of hotel rates for members of the association, their families and friends has been agreed upon:

One person per day.	Two persons per week.	Two persons for "the electrical season."
Annex room, $3.50.	Annex room, $40.	Annex room, $50.
Land view, 4.00.	Land view, 42.	Land view, 54.
Ocean view, 5.00.	Ocean view, 50.	Ocean view, 64.

The "electrical season" at Cape May will be from dinner on Saturday, the 16th, to include breakfast on Monday, the 25th. This secures nine days by the sea, with but seven business days.

The officers of the Association who will preside over and arrange for the coming convention are as follows: President, Marsden J. Perry; 1st. vice-president, E. A. Maher; 2nd. vice-president, C. L. Edgar; secretary and treasurer, Allen R. Foote; executive committee, C. R. Huntley, chairman, J. J. Burleigh, M. J. Francisco, John A. Seely, E. R. Weeks, James English, A. F. Mason, H. K. Thurber, C. H. Wilmerding; committee on entertainment, F. Theo. Walton, chairman, A. J. DeCamp, J. J. Burleigh, John A. Seely, Allen R. Foote.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, July 28, 1890.

Brooklyn, N. Y.—The Kings County Elevated Railroad Company has put up twelve new electric lights at the Brooklyn Bridge platform.

Amsterdam, N. Y.—The New York State railroad commissioners have granted the Amsterdam (N. Y.) Street Railroad Company permission to change its motive power from horses to electricity.

To Operate in Pelham.—George W. Cochran, Edward S. Becker and Benjamin Franklin are Trustees of the Pelham Bay Park Electric Light, Power and Storage Company just incorporated with $10,000 capital to operate in the town of Pelham, N. Y.

The Edison Industrial Works have been incorporated at Newark, N. J., with a capital of $1,000,000 in stock, of which $550,000 is preferred. The principal business will be at Silver Lake, near Bloomfield, N. J. The incorporators are Thomas A. Edison, Thomas Butler and Sherborn B. Eason.

A new line.—The new line of the New York & New Jersey Telephone Company to run through Rumson, N. J., has been marked out, and the work of construction is to begin at once. A number of the leading summer residents at Redbank, have signed telephone contracts. The company will open pay stations at Fair Haven and Oceanic.

Incorporated at Camden, N. J.—Articles of incorporation have been filed in the Camden County Clerk's office by the Electric Engineering Company. The objects of the corporation are to construct and equip electrical railways, cars and engines. The capital stock of the company is $100,000. The corporators are Harry Barton, Henry Gianella, Christopher Schneider and Thomas Marrin, all of Philadelphia, and Charles Richter, of Camden.

The Brush Company Enjoined.—An interlocutory decree, signed by Judge Coxe, of the United States Circuit Court, has been filed in the suit of the Brush-Swan Electric Light Company against the Brush Electric Company, of New York. The decree enjoins the defendant from interfering with the sales of plaintiff, and restrains the defendants from selling electrical appliances in the States and Territories held under contract for 17 years by the plaintiff. A referee was ordered to take testimony and report on accounting of defendants to plaintiff regarding sales.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD
Room 8, Cook Building, cor. Franklin and Congress Sts.
BOSTON, July 26, 1890.

The Pierce Bros. Trolley Company is equipping the Essex Electric Railway with its trolley holder.

Mr. J. N. Pratt, treasurer of the Jarvis Engineering Company, is in Chicago on a business trip.

Successful trial trips were run on the Augusta, Hallowell & Gardiner (Me.) electric railroad last week.

Ansonia, Conn.—The Ansonia Brass and Copper Company is to build a large addition to its rolling mills.

Hartford, Conn.—About 3,000 persons saw the Hartfords and Baltimores play base-ball by electric light one evening this week.

The Electrical Safety Company has received a large order from the Pennsylvania Railroad Company for the Cartwright protectors.

Will Rebuild at Once.—It is reported that the Anglo-American Electric Light Company at Kensington, Conn., whose plant was burned out recently, will rebuild at once.

Mr. Geo. F. Evans, of the Evans Friction Cone Company, this city, is at the Hotel Waverly, Philadelphia, for a few weeks, the numerous orders for his company's apparatus in that vicinity having made the trip necessary.

Thomson-Houston Stock Pool.—It is said that there were only about 100 shares of Thomson-Houston stock withdrawn from the pool within the period named by the trustees, which expired July 15, and the holder of this block desired, it is reported, to return it.

The National Telephone Company, of Boston, reports that it is making large shipments of its non-electric telephones to all parts of the world. Some of the largest shipments recently made were to Mexico and Peru in foreign countries, and to Colorado and Pennsylvania in the United States.

President S. E. Barton, of the Electric Mutual Insurance Company, returned from New York, this week, with a broad smile illuminating his countenance. Rumor has it that it was caused by his "scooping" in some $54,000 worth of the choicest electrical risks for the "Mutual" and other companies which he represents.

The National Electric Service Company, of which Wm. F. Chester is the Boston agent, has successfully equipped Osborne and Sever Halls, at Harvard College, the Roxbury High School and the John Hancock Building with the Johnson heat regulating apparatus, and the new Ames Building with heat and ventilating apparatus. The temperature by this system is regulated with a thermostat.

The Manet Street Railway, operating the Sprague system and running from Quincy, Mass., to Hough's Neck, was successfully tested last Friday and Saturday, under the direct supervision of Chas. B. Raub, the electric engineer. From 100 to 125 passengers were carried per car over difficult grades, testing the system very thoroughly and demonstrating that the electrical apparatus is in very good condition.

Rapid Transit in Newton, Mass.—A party of gentleman consisting of President Morse and the directors of the Newton city government and others enjoyed a trial trip last week over the line of the Newton Electric Railroad. The car started from the central station, and, after proceeding to Newton, traversed the line to Waltham and then returned to the central station. The electric motor worked successfully.

The Evans Friction Cone Company, of Boston, is fitting the whole of the machinery plant for the Leavenworth (Kan.) Electric Light Company. Two Ball engines, coupled to two 18-foot lengths of shafting, driving five Thomson-Houston arc dynamos, and three 70-h. p. Heisler incandescents, are some of the principal features of the station. The plant has been especially designed for the use of the Evans apparatus, and will have one of the finest lines of shafting in the United States.

The Thomson Electric Welding Company has built a machine especially for the welding of scrap steel to be drawn into fence wire. The Illinois Steel Company has tons and tons of steel rod scrap which it has been obliged to melt over in order to utilize it. The company invited the welding company to experiment with this scrap, which it has done successfully, and it will now build machines for practical work. These machines will yield the company $1,200 advance rental, and a royalty of one cent per weld during the life of the patents. It is said that other steel works than the Illinois company are likely to use this process.

Mr. L. H. Rogers, the New England representative of the Brush Electric Company, has just closed a contract for an alternating electric light plant for the town of Woodsville, N. H. The machine to be built will be one of the new style Brush alternaters, a number of which Mr. Rogers has placed in New England, and which are now running successfully. The system to be installed in Woodsville will be similar to the one now running in Bristol, N. H. There will be 41 lamps of 32 c. p. each, for street lights, all run in parallel, so that each lamp is independent of every other. The station now being built provides for two 600-light alternaters, one only of which will be installed at present. The Brush Electric Company will set poles, string about 20 miles of wire, and do all construction work, installing the entire plant. Lights are expected to be turned on about the first of September.

L. H. H.

PHILADELPHIA NOTES.

Mr. W. L. Woodruff, of the Southern District Telegraph and Electric Company, of Birmingham, Ala., favored this office with a call last week.

Mr. Henry B. Cutter has installed a 500-light plant for Messrs. George C. Hetzel & Co., worsted manufacturers, corner of South Thirteenth and Carpenter streets.

Chester, Pa.—Messrs. John M. Sharpless & Co.'s chemical works have put in a 200-light plant of the Standard system, through the agency of Henry B. Cutter, of Philadelphia.

Kittanning, Pa.—The new Opera House has just been fitted throughout with combination fixtures by the De Kosenko & Hetherington Manufacturing Company, of Philadelphia.

New Armature.—Mr. N. H. Edgerton has just been granted a patent on a new dynamo armature. The new feature is the making of the armature core out of sheet iron, spirally wound about the shaft of the dynamo and electrically welded at each end.

Business Changes.—Henry B. Cutter has been elected treasurer and manager of the Spellier Electric Time Company, and will commence active service for the company about August 1, when he will move his present office to 27 South Eleventh street, where the Spellier Company is now located.

The Wenstrom Consolidated Dynamo and Motor Company, of Baltimore, has purchased of Chadbourne, Hazleton & Co., of this city, their patent gearing for railroad purposes, and will prepare to manufacture the same at once. The electrically

actuated elevator, owned by Chadbourne, Hazleton & Co., has also been purchased by the Wenstrom Company, and large orders have been taken throughout the United States.

Election of Officers.—At a meeting of the Eclipse Electric Company (capital $300,000), held recently in Washington, D. C., the following were unanimously elected officers for the ensuing year: Gen. Edward F. Beale, president; John H. Walter, vice-president; W. Mosby Williams, secretary; Henry K. Simpson, treasurer; Frank Aldrich, general manager; John Ridout, attorney; Rev. B. F. Bittinger, A. M. Lothrop, S. Oppenheimer, Gen. Albert Ordway, George I. Hill, Rev. Dr. John Chester, George P. Bohrer, E. H. Neumeyer, W. H. Acker and T. L. Jeffords, directors.

W. F. H.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, July 26, 1890.

Blaine, Wash.—Work on an electric plant has begun.

An electric club is to be organized at Nashville, Tenn.

Mr. John E. Wiles, of storage battery fame, is over from Detroit passing a few days with friends in Chicago.

Mr. William J. Clark, the general agent of the railway department of the Thomson-Houston Electric Company, is a welcome visitor in Chicago this week.

Mr. A. M. Morse, of English, Morse & Co., contracting engineers, Kansas City, called on several friends in Chicago this week while en route home from the East.

The officers of the Badger Illuminating Company, Milwaukee, Wis., are E. C. Wall, president and general manager; D. S. Wegg, vice-president; and R. L. Jennings, secretary and treasurer.

Little Rock, Ark.—The City Council has granted the street railway company the privilege to change its motor power to electricity. Estimated cost, $300,000. Work will begin at once.

At Detroit, Mich., United States Judge Brown denied the injuction asked by the Brush Electric Light Company restraining the Detroit Company from using iron towers for electric lights.

San Francisco, Cal.—The California Electrical Works has entered a bill of complaint in the United States Circuit Court against Julius Finck for infringement of patent on a device for electric gas lighting.

The Chicago Novelty and Electr cal Company has been incorporated to manufacture and deal in novelties and electrical goods. The capital stock is $50,000, and the incorporators Foree Bain, Matthew Burton and J. W. Hutt.

To be Put Underground.—Corporation Counsel Hutchinson, of Chicago, has prepared an order calling upon the Hyde Park Electric Light Company to immediately place underground all its wires south of Jackson Park and east of the Illinois Central Railway.

Mr. Channing T. Gage, the Michigan representative of the Heisler Electric Light Company, was in Chicago this week in the interest of his company. Mr. Gage recently installed a Heisler plant in Union City, Michigan, that is highly spoken of by the local press.

The United States Electric Car Company has been incorporated to do business in Chicago to manufacture electric cars and motors and operate the same. The capital stock is $3,000,000, and the incorporaters are M. S. De Bolt, J. H. Donnelly and John A. Qualey.

Mason City, Ill.—The Mason City Electric Light Company's plant took fire on the morning of the 25th ult. and was totally destroyed. The fire is supposed to have been caused by a spark from the engine. Loss about $5,000. W. R. Porter is said to be the greatest loser.

Electric Lighting Proposals.—The board of trustees of West Indianapolis, Ind., will receive sealed proposals until August 18 for lighting the streets by electricity for a period of seven years from the 20th of next October, with 40 electric lights of 2,000 c. p. each. Jacob L. Mabee is president of the board of trustees.

'Twas Not an Advertising Scheme.—Mr. F. S. Terry did not furnish those handsome white badges to the long column of men parading on Randolph street last week, even though the letters P. & B. did appear thereon in unusually large type. It was merely the annual parade of a protective and benevolent society.

Westinghouse Purchase in Chicago.—The Chicago *News* says that the Westinghouse electric people have purchased for $480,000 the Morgan tract, 480 acres, located at the southeast corner of Halsted and 119th streets. The sale is at the rate of $1,000 an acre. It all lies in sections 28, 39, 14, and the Pan Handle road runs diagonally through the tract.

Crookston, Minn.—Manager Murphy, of the Grand Forks (N. D.) Gas and Electric Light Company, has closed a deal in Crookston, Minn., whereby he owns the water power, water works, gas works and electric light plant of that city. The purchase price was $175,000. Mr. Murphy assumes the presidency of the new concern; George B. Clifford is treasurer.

The Underground Electric Lighting Company, to furnish light, heat and power, has been incorporated in Chicago, with a capital stock of $1,000,000. The incorporators are Andrew J. Cooper, Charles A. Munsen and Frederick G. O'Connell. Negotiations are pending for the purchase of the South Side Electric Light Company's plant at Nineteenth and State streets, Chicago. The company has adopted the Fort Wayne alternating system. It is reported that the capital stock will be increased to $5,000,000.

Telephone Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$298@$300	Cumberland	$ 59@ $60
Central Union	68@ 69	Wisconsin	116@ 117
Michigan	98@ 99	Bell of Missouri	140@ 145
Great Southern	30@ 32	Iowa Union	21@ 23
Colorado	38@ 40	Missouri and Kansas	54@ 55
Rocky Mountain Bell	40@ 45		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$104@$105	Chicago Edison Co	$125@$130

Union City, Mich.—Concerning the new lighting plant of the city a local paper says: "The plant was purchased of the Heisler Incandescent Lighting Company, of St. Louis, Mo., several months since, through its efficient agent, Mr. Channing J. Gage, the purchase being made by our own enterprising citizens, F. C. Rheubottom and W. H. Bond. The plant is conveniently located in their factory on Broadway and has now been in complete operation about a month, giving satisfaction to a degree even exceeding all anticipations. The plant has been put in under the personal supervision of Mr. Gage and the work has been done in a manner which reflects much credit upon his ability in this direction.

Seattle, Wash.—Articles of incorporation of the Kirkland Investment Company have been filed by A. B. Stewart, Jacob Furth, A. P. Mitten, Jasper Compton, Peter Kirk, Bailey Gatzert, H. E. Holmes, L. S. J. Hunt, H. G. Struve, Maurice McMicken, and F. J. Grant, of Seattle, and Walter Olds, of Indiana. The capital stock of the corporation is $120,000, divided into 1,200 shares of $100 each. Some of the objects set forth in the articles are to build, acquire, equip and operate railroads and street railroads, operated by horse, electric, cable, or other power; to construct, acquire and operate electric light plants, and to furnish electric light and power for municipal, domestic and manufacturing purposes, and to construct and operate telegraph, telephone and district telegraph lines.

F. De L.

SOUTHERN NOTES.

Norfolk, Va., July 26, 1890.

Marion, N. C.—An electric plant is in contemplation. The Marion Land and Improvement Company can give full particulars.

A New Telephone Line.—A telephone line from Linville, N. C., to Cranberry, in the same state, is being constructed, and the poles have already been placed.

Telegraphic Line Completed.—The telegraph line which was being constructed between Blowing Rock, N. C., and Boone, the county seat of Watanga, was completed on the 14th instant.

Suffolk, Va.—H. E Elam and Elmer Thomas, contractors, have completed the electric signal which connects the fire-engine house and the pump house at Lake Kilby, and the work has been accepted by the city council.

Waynesboro, Ga.—Arrangements have been completed for the establishment of an electric light plant to furnish illumination for the streets. The stock of the company was quickly subscribed, and the organization will take place immediately, when the machinery will be ordered with the smallest delay possible.

Monroe, N. C. An election is shortly to be held to decide on the question of issuing $20,000 of town bonds for the establishment of an electric light plant. There is practically no opposition to the project, and the election will, do doubt, be overwhelmingly, if not unanimously, in favor of the contemplated improvement.

Richmond's Electric Fan Boom.—Richmond is now in the midst of an elecric fan boom. Last year only a few were seen there, but now dozens of establishments have them, and they bid fair to be adopted by every house that can see its way clear to afford the luxury, and they undoubtedly are a most enjoyable luxury with the mercury endeavoring to get out at the top of the thermometer.

Charleston, S. C.—The telephone subscribers have recently been placed to a good deal of inconvenience by reason of the crossing of wires. This has been due to the fact that for the past week or two a great deal of construction has been going on, necessitating the putting up of new poles and the removing of old ones, and the renewing and readjusting of wires. Superintendent Torbert, of the Charleston Exchange, is pushing the improvements with his accustomed vigor and will soon have his lines in fine working order again.

Shall Richmond Own Its Own Electric Light Plant?—The present City Council of Richmond, Va., will be expected to consider the propriety and advisability of making an appropriation of $75,000 for the establishment of an electric light plant. That this step in local legislation is a needed matter is conceded quite generally. The city gas works have proved a good investment for Richmond, and specially ought an electric light plant to become a profitable piece of property. This is the argument advanced by some of the headstrong citizens of the Capital City. But there are more cautious ones who oppose any immediate steps being taken toward the establishment of an electric light plant, because they claim that electric light machinery has not yet reached that stage of development when it would be safe for the city to make a large expenditure for it, and that in a few years newer devices may render comparatively worthless the equipments purchased.

Telephone Work in Atlanta, Ga.—Not long since the City Council passed an ordinance stipulating that telephone wires shall be run only on one side of a street. On some streets the telephone company had so many wires they had to erect poles on both sides of the street, and this ordinance was intended to put a stop to their encroachment. To conform to the new ordinance General Manager W. T. Gentry decided to string certain of the more crowded streets with lead cables, which are to contain 50 copper wires thoroughly insulated, and so constructed as to compress that number of conductors into the smallest possible space. In addition to the cable already up, the telephone company is placing five more, all leading out from the central office and going as follows: One to the corner of Peachtree and Edgewood avenue, one to corner of Whitehall and Alabama, at Capital City Bank, one to corner of same street on the opposite side of Whitehall, one to corner of Alabama and Pryor streets and one to the corner of Alabama and Loyd streets, making in all about 5,000 to 6,000 feet of telephone cable, containing something over 50 miles of insulated copper wire. When this work is completed Manager Gentry intends taking down the telephone wires on Marietta street from Broad to Peachtree, and on the east side of Broad street from Marietta to Alabama streets, also about 50 of the wires on the west side of Broad street from Marietta to Alabama and Whitehall streets. While making the changes from wires to cables there is no discontinuance of the service, and the subscribers are not disturbed by the great change going on. A record of each wire is kept as it is changed, and when it is connected to the distant end of the cable, the same conductor in the central office is connected to its original number in the switchboard. Every conductor in these cables is being accurately tested and located at each end, and such change occupies only a few minutes; but owing to the great weight of the cables the workmen in stringing them unavoidably break some of the overhead wires, and this is the only disturbance which the patrons of the telephone exchange experience. Manager Gentry expects to complete the stringing of the lead cables during the present week, and will probably get through changing the wires by another week.

Y. N. B.

ENGLISH NOTES.

(*From our own correspondent.*)

London, July 16, 1890.

The Lane-Fox Patents.—The operations of the company, which was formed with the modest capital of £100 for the purpose of obtaining royalties from electrical supply companies and others on the strength of Mr. Lane-Fox's distribution patent, have come to a deadlock. The company has arrived at the conclusion that there is no hope of the patent being recognized without a battle in the law courts, and this they are not prepared to engage in. Unless, therefore, some group of financiers can be induced to take the matter up it may be presumed that we have heard the last of this unfortunate patent, which its last owners were sanguine enough to believe covered the entire ground of constant potential distribution in conjunction with accumulators as "reservoirs of electricity."

The Edinburgh Meeting of the Institution of Electrical Engineers.—The three days' meeting of the Institution of Electrical Engineers at Edinburgh, which began yesterday, promises to be a great success. There was a muster of over one hundred members at the inaugural sitting, and the first papers on the list were appropriately on "Some features, mainly electrical, of the Edinburgh Exhibition," by Dr. R. Mullineux Walmsley. In the brief discussion which followed the reading of this paper, Mr. Preece referred with some degree of pride to his discovery of the Delany multiplex instrument, and to the fact that while it was working successfully on some 16 important circuits in this country, no use was being made of it in the land in which it originated. Dr. Walmsley's paper was followed by one on "Currents in Aerial Conductors," by Mr. A. R. Bennett, of the National Telephone Company. The most important paper, however, is one which will be read by Prof. Ayrton on "The Efficiency of Accumulators." The experiments upon which the conclusions arrived at are based have extended over a long period, and as ordinary working currents have been employed, this paper should form a valuable addition to our somewhat scanty knowledge of the actual commercial efficiency of the storage cell.

The National Telephone Company.—Now that the question of Government purchase is settled for the next seven years, public attention is being directed to the policies which the Post Office and the National Company, respectively, intended to purchase in the immediate future. As I mentioned in my last letter, the post office officials seem to be inclined to enter into competition with the National Company, both directly and indirectly, through licencees. As to the future policy of the National Company very little was said by its president, Mr. F. R. Leyland, at the meeting of the shareholders on Friday last, and we can only surmise by the general tone of his speech and the large sum (£40,000) added to the reserve fund that all attempts at competition will be promptly and boldly met. More interesting than the vague statements as regards future policy was the very clear exposition of the present prosperous financial position of the National Company. Since the amalgamation of the three largest telephone companies a year ago their gross revenue has increased 14 per cent., *i. e.*, from £343,000 to £392,000, and their working expenses have decreased 7 per cent., the result to the shareholders being a dividend of 6 per cent. The metropolitan system has been and is being overhauled, trunk line extensions are being vigorously carried out, and the policy of consolidation is being steadily pursued, the Northern District Company being the last absorption, leaving but two companies outside, and these evidently eager to combine. Finally, the long-promised trunk wire connecting London with the North has been completed. The public is undoubtedly somewhat disappointed at the decision of the government not to purchase the telephone system, and it will, therefore, be ready to support competitive companies. It is to be hoped, however, that the National Company will render competition unnecessary by a reasonable reduction of rentals and a general improvement of its service where defective.

News of the Week.

THE TELEGRAPH.

The Western Union Company officially states that its loss by the burning of its building is $100,000.

A South American Cable.—The Silvertown Telegraph Company, of England, is manufacturing about 1,750 miles of cable for the Central and South American Telegraph Company. This cable will be laid on the west coast of South America, connecting Valparaiso direct with Iquique, and Iquique with Lima.

Increase of Capital.—The Pacific Postal Telegraph Cable Company has increased its capital from $500,000 to $600,000, a certificate to that effect having been filed at Albany, N. Y., with the Secretary of State. This is signed by John W. Mackay, Hector de Castro, Charles R. Hosmer, Albert B. Chandler, George G. Ward and Edward C. Platt.

Election of Officers —At the annual meeting of the stockholders of the Vermont & Boston Telegraph Company, July 23, at White River Junction, Vt., the following directors were chosen: Norvin Green, T. T. Eckert, C. A. Tinker, R. H. Rochester of New York, Thomas Roche and H. C. Sherman of Boston, R. J. Kimball of West Randolph, Vt., G. W. Smith and H. E. Tinker of White River Junction, Vt. The directors subsequently elected Norvin Green president; T. T. Eckert and C. A. Tinker, executive committee; R. H. Rochester, secretary and treasurer.

To Connect England and Sweden.—The Great Northern Telegraph Company, of England, contemplates laying down one or two new telegraph cables between Scandinavia and England. A cable will be laid between Gothenburg, on the Swedish side of the North Sea, and Newcastle-on-Tyne on the other side. This will be the first direct cable between Sweden and England. The new cable is expected to bring about a material increase in the Swedish telegraphic intercourse, as a large number of telegrams are likely to be sent by the new line from Russia and Northern Asia to England.

The Richards Electric Company is a new concern, organized under the laws of Maine, with a nominal capital of 100,000 $10 shares, $1,000,000, and having an office at No. 3 State street, Boston. The company is based upon an improvement in telegraphy invented by Mr. Walter S. Richards, of Natick, Mass. The inventions are directed toward increasing the efficiency of the telegraphic and fire alarm service through a diminished cost of battery power. The system has been tested over Western Union wires, between Boston and New York and intermediate points, and over long distance telephone wires to New York.

Identifying the Wires.—An interesting sight was to be seen on the fourth floor of the Western Union Building, at 195 Broadway, the Monday after the fire. All the cables that led into the battery room on the sixth story had been brought down here, and the work of finding out where the hundreds of wires ran was begun. Each wire had to be connected to an instrument, which was mounted upon a dry-goods box. This is a sample of the telegraphic conversation that was carried on: "I. I. N. Y. Who's on this wire?" Then would follow a silence of a second or so, when the sounder would click: "Buffalo is here." "What's the number of the wire?" "44." And so it went all day long. One minute Albany was talking, and then it was Washington, Philadelphia, Boston, or, perhaps, some Jersey town. As fast as a wire was identified it was labeled with a tag and run up to the floor above, where carpenters, linemen and operators worked together. Before 5:30 P. M., the hour when the day force quits work, there were 300 operators, men and women, sending and receiving messages.

Western Union's New Building.—The directors of the Western Union Telegraph Company have decided to remodel the upper stories of their main building, which were destroyed by fire recently. The general conduct of the work has been intrusted to Vice-President Eckert. The roof and walls will be taken down to the sixth floor, and to that will be added four stories. The walls will be carried straight up, and in the new structure there will be neither tower nor mansard roof. The new roof will be flat, sloping slightly toward the centre. The whole building will be lengthene

25 feet by the erection of an addition on the lot No. 8 Dey street which has long been owned by the company. The new part will be built in conformity with the present building. The changes will enable the putting in of new elevators, which will run to the upper floors instead of the middle floors as in the former building. The number of elevators will be increased to four. The operating rooms will be on the highest two floors, the main one on the top floor. They will be planned so that they will afford the utmost convenience and safety. There will be no battery room except in the basement, and the number of dynamos may be increased whenever further power is required. The improvements will probably cost $500,000 and it is not expected that they will be finished before January.

Suit to Annul Telegraph Contracts.—A telegram from St. Paul, Minn., of July 22, says that a bill in equity has been filed in the United States Circuit Court against the Northern Pacific Railroad Company, the Western Union Telegraph Company and the Northwestern Telegraph Company. These corporations, it is held, have failed to carry out the provisions of the acts of Congress of July 2, 1864, and April 10, 1869, in which to a railroad company were granted valuable concessions from the United States in lands. One of the provisions was that the railroad should erect and maintain a telegraph system. Subsequently the Northern Pacific made contracts with the Western Union and the complaint alleges that the contracts were beyond the powers of the defendant railroad to make, or the defendant telegraph companies to receive, and were induced by improper and corrupt considerations, against public policy, and in violation of the rights of the United States under the acts of Congress. The court is therefore asked to annul the contracts, and such other redress as may be just and proper is also demanded. The complaint is signed by Attorney-General Miller. The object of the proceeding is to forfeit wholly the rights claimed by the Western Union Telegraph Company under franchises alleged to have been derived from the Northern Pacific Railroad Company. The telegraph franchises in question extend over 2,189 miles of railway. The proceeding also denies the right of the Western Union Telegraph Company to succeed to the rights and franchises of the Northwestern Telegraph Company, of Kenosha, Wis., the United States Telegraph Company, the Atlantic & Pacific Telegraph Company, the Independent Telegraph Company, the Pacific Telegraph Company, the Overland Telegraph Company, and a number of others, the names of which are not specified. The complaint alleges that the Northern Pacific had no right to enter into the contracts with telegraph companies; that it was a breach of public trust, and a violation of the Northern Pacific charter.

THE TELEPHONE.

Quarterly Statement.—The New England Telephone Company's gross receipts for quarter ended June 20 were $347,410, and net $82,496. Construction was $18,123.

The Shaver Telephone Company has completed a line two and one-eighth miles in length at Nashville, Tenn. It is said to work admirably, giving a message clearly and distinctly.

Dividend.—The New England Telephone Company has declared the usual dividend of 75 cents per share, payable August 15 to stock of July 31. The transfer books will be closed from August 1 to August 14, inclusive.

English Telephone Service.—The inefficiency of the London Telephone service leads the *St James's Gazette's* to remark: "There is one change, however, which would not improve the service, and that is for the government to take it over. The telephone would at once become stationary, like the telegraph."

Increase of Earnings and Subscribers.—The Erie Telephone Company's net increase of earnings for April and May of this year exceeds the same two months of last year $13.000, and the first two months of this year (January and February) $3,000. The net increase of subscribers for June was 124, making a net gain for the first quarter of the fiscal year of 417.

Bell Company again Victorious.—In the United States Court, at Parkersburg, Va., on July 9, a perpetual injunction was granted to the Bell Telephone Company restraining the Long Telephone Company from making or using any telephone under a patent claimed by Charles W. Long on the ground that these Long instruments were an infringement upon the Bell patent. The case has been pending a long time, and its decision removes the last rival of the Bell Telephone Company in this State.

Telephone Bonds.—The American Bell Telephone Company has the right to redeem, on Aug. 1, the $2,000,000 debenture 7 per cent. bonds at $110 issued to stockholders at par Aug. 1, 1888. These bonds, which are really notes of the compa y, were drawn for 10 years, with the proviso that it could redeem them at $110 in two years or on any quarter-day thereafter. Rights to take these bonds sold at $2 each, and were in the proportion of $1.000 bonds for five shares of stock or five rights. The interest on the $2,000,000 bonds now aggregates $140,000.

Output of Instruments.—The comparative figures of the output of telephones by the American Bell company for the month ended July 20 are as follows:

July.	1890.	1889.	Increase.
Gross output	4,787	4,122	665
Returned	2,887	2,390	497
Net output	1,900	1,732	168
Dec. 21 to July 20.			
Gross output	38,364	34,338	4,026
Returned	14,991	13,671	1,320
Net output	23,373	20,667	2,706
Instruments in use July 20	468,234	432,208	36,026

Poles for Telephone Lines.—A writer upon this subject in one of our contemporaries says that telephone wires require a better quality of pole than telegraph wires alone. The poles must be as nearly perfect as possible, and of uniform height, else there will be vibrations that will prevent the carrying of sound a long distance; imperfect poles would cause what telephone men call a noisy wire. Every pole is numbered, and a record of it is kept, which gives its history. It is known, for instance, in the construction department of the company, whether pole 1,346 stands in an open field or at the road side or in a wood, how many wires are on it and how they are arranged, when the pole was inspected, and its condition of soundness.

THE ELECTRIC LIGHT.

Gainesville, Ga.—A new dynamo will be added to the city lighting plant in the fall.

Cleveland, Tenn.—W. S. Beckner and others contemplate erecting an electric light plant.

Arkadelphia, Ark.—An electric light plant will be installed in the Methodist College, now building.

Dawson, Ga.—The mayor of the city is negotiating for the establishment of an electric light plant.

Alexandria, La.—It is reported that a stock company will be organized to establish and operate an electric light plant.

Lincoln, Neb., boasts of an electric lamp factory turning out 250 complete lamps per day, with a prospect of an increase to 1,000 lamps a day within a year.

Dallas, Tex.—The Dallas Electric Company has filed a charter with J. P. Smith, J. B. Kirby, and E. L. McDonald, as incorporators, with a capital stock of $300,000.

Electric Headlights.—A Louisville (Ky.) paper says that the "Vandalia Route" now has ten of its engines equipped with electric headlights, and will at once equip eight more.

Tazewell, Va.—The Tazewell Court House Improvement Company, organized with B. W. Stras, president, and Joseph Stras, secretary, contemplates erecting an electric light plant. This company owns 152 acres of land, and has a capital stock of $100,000.

Middlesborough, Ky.—The Thomson-Houston Electric Company, of Boston, Mass., has, it is reported, purchased the electric light plant of the Middlesborough Gas & Electric Company for $30,000, and will organize a stock company to operate the same.

Bonds for Sale.—The Consolidated Gas and Electric Company, of Batavia, N. Y., which owns the entire gas and electric light franchises of that place, is offering for sale part of an issue of $80,000 first mortgage six per cent. 20-year coupon bonds, secured by real estate and chattel mortgage on the property and franchises of the company.

Woonsocket, R. I.—The Edison Company is installing a 1,500-light plant in the works of the new rubber company; the Thomson-Houston Company is installing a 400-light plant in the Glenark Knitting works; and the Woonsocket Electric Machine and Power Company is doing an extensive business in the lighting of private residences on the meter basis. It is said that the customers find it fully as cheap as gas.

Electric Light Station Burned.—The electric-light station in Ware, Mass., was destroyed by fire at 4 o'clock Monday morning of last week. The plant was owned by the Thomson-Houston Electric Company. It was started two years ago and has been in successful operation since. The building was a total loss and the dynamos and other machinery except the boiler were destroyed. The loss is estimated at $12,000; insured for $5,000.

At the "Horse-shoe" Tavern, Tottenham Court Road, London, a sign is being erected in the shape of a colossal horse-shoe for illuminating by electricity. The horse shoe is made of bent American elm, hollow, and studded on each side with large lenses, exactly opposite each other. Between the lenses Edison lamps are placed. The sign, which is 8 feet 9 inches high and 8 feet wide at its greatest breadth, contains 32 lamps of 8 c. p., fed by 19 strands of No. 16 wire.

Construction of Contract for Lighting a City.—A contract for lighting a city for a series of years, with gas or electric light, the payment of which is to be made from month to month, is not, it has been decided, the contraction of a debt within the meaning of the Louisiana statute, forbidding the contracting of any debt without fully providing in the ordinance creating the debt the means of its payment, but only of such a debt as the city is bound to provide for in its annual budget in accordance with the positive mandate of the law. This decision was rendered in the case of the New Orleans Gas-Light Company vs. City of New Orleans, in the Supreme Court of Louisiana.

APPLICATIONS OF POWER.

A "C and C" motor, with fan attached, has been placed in the office of Superintendent Rice of the Thomson-Houston Company at Lynn, Mass.

Electric Railway Bonds.—The Birmingham Railway & Electric Company, Birmingham, Ala., held a stockholders' meeting on July 26, to consider the issuance of $1.500,000 of negotiable first mortgage consolidated bonds.

To Connect Three Towns.—An electric railway is to be built to connect East Portland, Ore., with Sellwood and Milwaukie. The line will be six miles long. The company has abandoned its intention of using steam motors. It has not yet been decided what electric system will be used.

East Portland, Ore.—The Waverly-Woodstock street railway is being equipped with the Thomson-Houston system. It will cross the Morrison street bridge to Portland. A part of the machinery and dynamos for use at the power house are on the ground and will be set up as soon as possible.

New Company Organized.—The East Side Street Car and Motor Company has been organized at Baker City, Ore., to build and operate motor lines within the city limits. The capital is $25 000, and the incorporators and directors are J. P. Faull, George Waggoner, P. Basche and J. H. Parker.

Will Change Steam for Electricity.—At East Portland, Ore., the Hawthorne avenue railway is now operated by steam motors, extending out to Mt. Tabor, a distance of four miles. The superintendent, Mr. George Brown, states that it will be operated in the near future by electric instead of steam motors.

From Pittsburg to Braddock.—The Second Avenue Electric Railway, whose line starts at Pittsburg and terminates at Glenwood, a suburb five miles distant, is seriously considering the extension of its tracks to Braddock, five miles beyond. No work, however, has as yet been done upon the projected road.

Lynn Belt Line.—Active operations are in progress on the new electric line with which the Lynn & Boston Railroad is to encircle Lynn. Within a week eight miles of wire have arrived, part of it for overhead and the rest for the underground return wire. This latter is now being laid by Messrs. Kendall & Slade, of Boston, who have the contract to build the road.

Dynamo Men Not Eligible.—The Building Trades' Council of Pittsburg, an organization recently formed in the interest of those engaged in the various branches of building, has decided to admit to its ranks electric wiremen, but declines to entertain propositions for membership from dynamo men, it being considered that dynamo runners do not come within the scope of the society.

Permission to Build.—The West Orange Township Committee on Monday evening unanimously passed a resolution giving the Essex Passenger Railway Company the right to build a road from the Orange line through Main St. along Valley Road to Tory Corner, and thence up Eagle Rock Ave. to Bramnall Ave. Permission was to be given for electric propulsion by the overhead system.

A Large Dynamo.—A new 250-h. p. generator, the largest ever built in this country was assembled last week in the factory of the Thomson-Houston Electric Company at Lynn, Mass It is for use in the transmission of power for electric street railways, and is now in the welding shop, the only place where it can be tested at present. It is 8½ feet high and weighs 23 tons. It will go into the West End Company's power house in Boston.

Allegheny City's new tower system is receiving varied criticism now that it is fairly in operation. Many of the citizens are exceedingly pleased with the effect of the lights high in the air, while others express themselves as believing better results could have been attained by the employment of the methods used in the sister city of Pittsburg, where the arc lights gleam brightly from the center of the streets, suspended on mast arms.

Boston to Brockton by Electricity.—The selectmen of Avon, Mass., held a hearing recently on the petition of the Brockton (Mass.) East Side Electric Railway Company to lay tracks in the town from Brockton to the Randolph line. Lloyd Chamberlain, for the petitioners, presented the case, and, as there is no objection, the required permission will undoubtedly be granted. It is a part of a scheme to connect Brockton by electric road with Boston.

Street Railway Voltage Limited.—Superintendent Morris Mead, of the Pittsburg bureau of electricity, recently served notice on the electric railway companies running cars in the city that their voltage must be within the limit of 800 volts. The officers of the Second avenue and Pleasant Valley line on being interviewed said that this requirement would in no wise hamper them, the voltage actually used on their lines rarely going beyond 500 volts.

Electric Mining Apparatus.—W. H Brown & Sons are the latest coal operators in the Pittsburg district to evince a practical appreciation of electricity as applied to mining. Their mine No. 1 is now being fitted up with an electric system which will mine the coal, propel the wagons and afford illumination throughout the mine. The Hercules mining machine, manufactured in Pittsburg forms a part of this system. The Tesla motor, manufactured by the Westinghouse Electric and Manufacturing Company, is also employed.

Motors Wanted for Electric Cranes.—The new foundry for the Pratt & Cady Company at Hartford, Conn., will be designed and built by the Berlin Iron Bridge Company, of East Berlin, Conn. The building will be 250 feet long by 75 feet wide, and it is the intention of the Pratt & Cady Company to have a traveling crane run the entire length of the building, besides a large number of jib cranes scattered throughout the wings, all of these cranes to be operated by electricity. Parties doing this class of work should correspond with the contractors.

MISCELLANEOUS NOTES.

First Award.—Messrs. Woodhouse & Rawson, United, Limited, have received a first award of merit for their display of electrical apparatus at the Exhibition at Dunedin, New Zealand.

Postal Phonograph System.—A telegram from the City of Mexico says that the government has granted Mr. Peniche, representing Mr. Edison, an extension of six months to establish a postal phonograph system.

New Electrical Laboratory.—Friends of Brown University, at Providence, R. I., are trying to raise $500,000 among graduates of the institution, the money to be devoted to the establishment of a technical school where thorough instruction in electrical branches can be given.

The English Welding Company.—The payment of £60,000 as a part of the amount due for the European patents of the Thomson Welding Company was not made at the time recently specified but it was announced that the City of London Contract Company would guarantee the payment if 21 days more time was allowed.

Electric Clock Installations.—Mr. Francis G. Du Pont, of Wilmington, Del., has equipped his residence and factory with a fine system of electric clocks furnished by the Standard Electric Time Company, of New Haven, Conn. The same Company has recently installed a plant in the "Wilder," a ten-story office building, Rochester, N. Y., through its local agents, Messrs. Rudolph Schmidt & Company.

A Multum in Parvo Lightning Flash.—The Norristown (O.), *Herald* says: "According to a telegram, 'lightning struck a man in Springfield, O., killed him, burned the sign of a cross on his back, and then dug a hole in the ground behind him the exact size and shape of a grave' It is also rumored that the electric bolt paid all the funeral expenses, ordered a monument for his grave, and offered to marry his widow; but this report lacks confirmation."

The Copper Market.—The Boston *Post* of the 23d ult. says: Bids of 17 cents for copper were refused today, and the mining companies asked 17½ to 18 cents. The sale of 100,000 pounds of ingot at 17 cents took place last Friday. In fact, not a pound of copper, as far as we can ascertain, has been sold at 17 cents since Friday. On the 24th the same paper said: "A sale of 25,000 pounds of lake copper at 17½ cents spot was made to-day. It was bought by a manufacturer, and is the highest price thus far recorded for a cash sale. The company making this sale says it will not sell futures at less than 18 cents."

Engineering Problems.—In order to promote and stimulate original investigation as well as to bring before the engineering public the results of such study, the British Institution of Civil Engineers has invited original communications upon a list of 50 topics which cover a wide range of professional work. Six of the subjects included in the list are of an electrical nature, and are as follows: Electric Meters for recording the Consumption of Electrical Energy; The Construction and Maintenance of Secondary Batteries; The Application of Electricity to the Working of Cranes, Pumps, Tools, etc.; The Application of Electricity to Smelting and Metallurgical Operations; The Application of Electricity to the Purification of Water and of Sewerage; The Purification of Copper, and the Reduction of Copper Ores by Electrolytic Processes.

PERSONALS.

Mr. W. C. McIntire, the sleepless and tireless agent of the Eddy Motor Company for New York and Philadelphia, was in New York last week on business, and called at our office for a few minutes.

Mr. C. E. Newton, of Hartford, Conn., was in New York last week and favored THE ELECTRICAL WORLD with a brief call. Mr. Newton is associated with the Jewell Belting Company and was in the city attending to business matters.

Entered into a Better Life.—Mr. Henry Harmon Neill, assistant editor of THE ELECTRICAL WORLD, was married on Tuesday, July 29, to Miss Alice B. Ogden, daughter of Frederic Ogden, of New York City. His many friends extend hearty congratulations and best wishes.

Mr. E. R. Flach, of the firm of T. H. Flach & Son, electricians and dealers in electrical goods at Buffalo, N. Y., was a caller at our office last week. Mr. Flach was in the city on business interests and endeavoring to secure the most improved electrical apparatus for his customers in western New York.

Mr. P. C. Ackerman, of the American Electrical Works, Providence, R. I., was at our office one day last week making inquiries for a railroad guide to Texas. It is rumored that he is

obliged to leave town because he is unable to secure wire from the actory fast enough to supply the demands of his customers.

Mr. M. E. Baird, of the Eddy Motor Company, Boston, was in the city last week and made us a pleasant call. Mr. Baird is just returning from his vacation and is ready for another years' prosperity in the motor business among the mills and factories of New England. He is now writing to his friends that he will meet them at Cape May at the National Electric Light Association meeting.

Mr. L. A. Derby, of Lowell, Mass,. brought a Colorado friend to our office last week and gave us considerable information as to the electrical progress in the far West as well as in his own city. Mr. Derby was formerly the head of the firm of L. A. Derby & Co., but is now associated with the Eastern Electric Light and Storage Battery Company, and will conduct for that company the manufacture and sale of storage batteries for electric light and traction purposes.

Mr. Ben M. Hammond, who is connected with the third annual Fair and Exposition to be held at San Antonio, Texas, September 30th to October 11th, was in New York the past week. Mr. Hammond is making a pleasure trip through the North and East, combining business with it in some degree. The directors of the Fair and Exposition offer space and power free to electrical companies, and any one desiring to take advantage of this offer should communicate with Mr. Hammond for the next ten days, care of THE ELECTRICAL WORLD.

Mr. P. N. Nunn, of Telluride, Col., is spending a few weeks in the East to ascertain the best methods of establishing an immense plant for the long-distance transmission of power in the gold-mining regions of Colorado. Mr. Nunn has been in Boston for some time, and came to New York last week to continue the examination of the most successful electric motors. The plant is to be installed by L L. Nunn & Co. to operate crushers at distances ranging from 3½ to 28 miles, and in power units from 30 to 100 h. p. A total of 300 or 400 h. p. will be required. The crushers are scattered along the San Miguel Valley at various distances and power will be obtained from a 600-foot waterfall. If Mr. Nunn succeeds in finding the cost of installation to be within the limit the company is willing to expend, he will establish one of the finest plants in the mining regions of the West.

Mr. Clark Beers Hotchkiss, who was one of the organizers of the district and telegraph messenger service in this city, died last week at Paul Smith's, in the Adirondacks. He was 42 years old, and was born in Auburn, N. Y. When he first came to this city he was engaged in the banking business, but in 1871 he assisted in the organization of the American District Telegraph Company, of which he was for some time the secretary and assistant treasurer. Then in 1881 he assisted in the establishment of the Mutual District Tele. graph and Messenger Company, and at the time of his death held the offices of vice-president and secretary. Mr. Hotchkiss was, however, better known to the readers of THE ELECTRICAL WORLD as the general agent of the Kerite wire, a position which he held until compelled to retire on account of failing health. Two years ago Mr. Hotchkiss became afflicted with consumption, and his time since then has been mainly devoted to efforts for the recovery of his health.

Industrial and Trade Notes.

Messrs. Elmer and Amend, 205-211 Third avenue, New York city, are now offering for primary battery and other purposes a chemically pure sal ammoniac.

Increasing Business.—Mr. Alfred F. Moore, of Philadelphia, manufacturer of wire and cable, is making arrangements whereby he will double his present producing capacity.

Central Station Switches.—A lot of three-pole central station switches of remarkably handsome finish were shipped west last week by J. Lang & Co., 44 Michigan street, Chicago, who makes a specialty of this class of work.

Electric Welding Machines.—The Thomson Electric Welding Company has received orders for 12 of its new machines for welding scrap iron. The company has now 108 welding machines of various sizes out on royalties.

The New England Printing Telegraph Company is rapidly building its lines from Providence to Boston, and as soon as completed other lines now contracted for will be pushed. This company is said to have ample capital as well as an unlimited amount of enterprise, and will advance its work as rapidly as possible.

Chadbourne, Hazelton & Co., Philadelphia, have installed two 5 h. p. Wenstrom motors to operate four cranes at the Baldwin Locomotive Works. This company now has agencies established in New York, Boston, Chicago, Cleveland, Louisville, Pittsburg, Wilkesbarre, Wilmington, Baltimore, Washington, New Orleans, Denver and San Francisco, and is doing a thriving business.

The Nubian Iron Enamel Company, Chicago, if requested, will send to each reader of THE ELECTRICAL WORLD a sample of the work done with its special black enamel, designed for coating all metal work exposed to the weather, as, for instance, arc lamp frames, iron poles, etc. This enamel has been thoroughly tested by various electric light companies during the past two years, and the reports are favorable from all.

The de Kosenko & Hetherington Manufacturing Company has just equipped the Bank of Commerce Building and the Bittfield and Shady Side Presbyterian Churches in Pittsburg with combination fixtures, also the New York Life Insurance Building of Minneapolis, Minn. The company's business has outgrown its present quarters, and the company will soon be located in the fine Times Annex Building on Sansom street, Philadelphia.

Electric Launch Building.—The firm of Woodhouse & Rawson, United, Ltd., London, Eng., has purchased the business of electric and steam launch builders formerly carried on by Messrs. W. Sargeant & Company. Mr. Sargeant has been retained as branch manager. The Company intends to pay special attention to the building of electric launches and charging stations. The works are reported to be extremely busy with orders in hand, and enquiries are coming in freely.

The Walworth Manufacturing Company, of Boston, has actively begun the construction of electric railway poles in Pittsburg, Pa. It recently leased part of the Continental Tube Work plant and is making a specialty of these poles. On an average 95 poles are made each day. Additional machines will soon be put in position and the capacity doubled. The poles being made are 32 feet long, and are made of 6, 5 and 4-inch pipe forced together when heated and secured by means of a socket. It is the intention to make telegraph poles. An order has been received for poles 48 feet high. These will be made of 8, 7, 6, 5 and 4-inch pipe, and will be used for telephone and telepraph poles.

Mr. J. S. MacKenzie, a young electrician from Picton, N. S., was in the city one day last week completing arrangements with Mr. James H. Mason for handling his primary battery in Nova Scotia. A company will be formed for this purpose, with headquarters at Halifax. Mr. MacKenzie thinks there is a good prospect for doing an excellent business in this new field. So great has been the demand for these batteries that the Mason factory has been running at its full capacity from 7 A. M. till 10 P. M. for some time. Parties from Mexico have been making an exhaustive test of the battery, and, being fully satisfied as to its merits, have made arrangements to handle it in that section of the country.

The Great Western Electric Supply Company has the exclusive agency for the United States for electroliers made to represent all kinds of animals. The elk head electroliers at the company's Chicago store have already attracted much attention, and other novel features are promised. The company is building some special racks for showing its stock of colored and cut-glass shades, of which it has the largest and finest assortment in the country. In response to the description of the Pattee lamp hour recorder, published in THE ELECTRICAL WORLD two weeks ago, letters are now received from all parts of the country, showing the need of a simple meter. The specialties put out by the firm are described in a half-dozen special circulars, all uniform in size and neatly gotten up in different colors. The series is being added to week after week, and will supplement the preliminary catalogue now in the hands of the printer.

The Standard Thermometer Company, of Peabody, Mass., reports recent sales to the following companies. Hollingsworth & Vose, Walpole, Mass.; Geo. H. Friend Paper Company, Carrolton, O.; Howard Street Cable Road, San Francisco; Woonsocket Rubber Company; Salem, Mass., Electric Light Company; Remington Paper Company, Watertown, N. Y.; Brush Electric Light Company, Cincinnati, O.; Cincinnati Gas and Coke Company; Willamette Pulp and Paper Company, Oregon City, Ore.; Edison Electric Illuminating Company, Brooklyn, N. Y.; J. W. Burkett & Co., Washington, D. C. This company has lately made extensive additions to its factory, fitting it with new elevators, new Fitchburg engines and boilers, quadrupling its capacity. It has also added a 150-light Edison incandescent machine, and is now prepared to handle its growing business in good shape.

Mr. J. P. Cushing, 9-23 Knapp street, Boston, is probably turning out as fine work in the electrical and machine line as any factory in the United States to-day. Mr. Cushing originally started in business at the request of the Boston City government to manufacture the fine electrical instruments necessary for the municipal signal system and to put it in first-class shape. At odd times when not rushed with city business, Mr. Cushing has constructed experimental apparatus for ambitious inventors. Another of his special lines of work is the installation of electrical apparatus for theatres. At this Mr. Cushing excels. He has had a varied experience, having been employed by the Russian Government in building its telegraph lines through Siberia and in setting up the first nail and other improved machinery ever seen in that country. He was also in the service of the French and other foreign powers and has the very highest testimonials as to the character of his work.

Orders for Interior Conduit.—The success met with by the Interior Conduit and Insulation Company is said to have borne out the estimate of its utility by its projector, Mr. E. H. Johnson. Not only are new buildings in the East in course of construction equipped with it, but it has also been specified by architects in other new buildings throughout the country. Among these are the Board of Trade Building, Toronto; the Boston Building, Denver, Col.; the Bell Telephone Building, Boston, Mass.; New Jersey Central Depot; and the Seventh Avenue Music Hall and the German Club in this city. Its underground system has received a recognition seldom awarded a new article. It is carrying the alternating system of the Fort Wayne Jenney Company, at Detroit, with, it is said, very gratifying results. There will be employed at Minneapolis and St. Paul over 1,000,000 feet of this conduit for feeders. The tube, although made of paper, is very strong, tests made at Columbia College by Prof. Woolson showing that it had a tensile strength of 2,400 pounds to the square inch.

The Vulcanized Fibre Company, of Wilmington, Del., with its New York office, 14 Dey street, eastablished in 1873, to manufacture insulating material in sheet, rod, etc., for all electrical purposes, has met with unprecedented success, notwithstanding the fact that it has had to contend with all kinds of competition. During the half year just closed this company has done a larger business by 20 per cent. than in any similar period in its history, notwithstanding the fact that it added the plant of the Delaware Parchment Company last fall, increasing its capacity one quarter. The company is running to its full capacity, and is now putting in a 75 h. p. Corliss engine, made by the Wilmington Machine Works, of Wilmington, Del., to furnish power for additional machinery. It has just completed a two-story brick warehouse, with elevators, 35 by 78 feet, and detached from the main works, to be used for the storage and seasoning of manufactured goods, so that in event of fire in the factory proper there would be a full supply of material for customers. This is rendered necessary by the fact that the company has yearly contracts with nearly all the electric light and power companies of the United States, Canada and Europe, for a constant supply of material.

An Excellent Testimonial.—The Accumulator Company, 44 Broadway, New York, has received the following letter from Mr. F. Jarvis Patten, with reference to the qualities of its storage batteries: "Gentlemen: I have used your storage batteries constantly since November last at my laboratory here, as well as in Philadelphia. I have used the 15 *M* cell of your most recent and improved form for driving the distributor motors in my multiplex telegraph system. Also for past month I have used 60 cells of your smallest size battery originally designed for medical apparatus only, in lieu of about 125 cells of ordinary gravity battery for telegraphic transmission over the 100 mile circuit I use daily between New York and Philadelphia. With reference to the first lot, large size, used for motors, I am pleased to inform you that notwithstanding very irregular use, these cells have given me thorough satisfaction during the eight months I have had them in use, being more reliable for a constant E. M. F. than the dynamo circuit I use for charging them. The line battery to small cells occupying six cubic feet of space takes the place of more than 100 cells of gravity and require far less attention than the latter, and so far as observed give better results. I consider your improved forms of storage battery far superior to any I have seen in use, and with proper care in their handling, as to charging and discharging, they are an exceedingly convenient and reliable source of current."

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest. All inquiries must be accompanied by real name and address, as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Hertz's Discoveries.- E. C. C. will find some account of Prof. Hertz's very interesting work by himself in tolerably popular language in THE ELECTRICAL WORLD, Oct. 12, 1889.

Leclanche Batteries.—Will you kindly inform an old subscriber what is the great secret in making porous cup Leclanche batteries, or where can I can get full directions for the same?

X. A.

Home-made Leclanche batteries usually do not work very well. One of the great points in manufacture is the intimate mixture of the deporalizing material packed around the carbon, but nearly every manufacturer has methods which he keeps to himself concerning the best mode of preparing the material. We do not know of any place where you can get information as to these improved batteries. You already probably have the formulæ for the older forms. You might try the method given in Hopkins' "Experimental Science," page 405, if you would care to go to considerable trouble.

Electric Motor.—1. I have the simple electric motor described in Hopkins' "Experimental Science." The armature is 3⅞ inches outside diameter and is wound with 24 coils, four layers, eight convolutions each, No. 20 wire. The field magnets are shunt wound with five layers, 44 turns and No.18 wire. 2. For soft iron magnets, how many volts and ampères ought I to get at 2,000 revolutions, and what part of a h. p should I be able to get from it by using a large plunge battery?

F. H. M.

1. The data you give can furnish no idea whatever of the probable voltage, because you give neither the permeability of your iron nor the air space, on both of which factors the strength of voltage, which is the determining quantity of electromotive force. Your armature, however, will not stand more than five or six ampères. 2. The one-twentieth of a h. p., or thereabouts.

Incandescent Lamps.—Suppose we have an incandescent lamp of 50 ohms and 50 volts. Two such lamps in multiple would have half the resistance and twice the current. How is it that they require an expenditure of twice the energy, the electromotive force being constant and the current only increasing as the resistance diminishes?

STUDENT.

This is a question that not infrequently puzzles students, but is simple enough if one considers the properties of conductors in multiple. The mains being at constant potential, through any lamp connected across them, the same current must flow whether it is a single lamp or one of a thousand connected in multiple arc. In other words, the potential difference across the terminals of each lamp being the same and the resistance of that particular lamp being quite unaltered by the presence of other lamps on the same circuit, the current required is the same as if the lamp were alone; in other words, each lamp takes a definite amount of current, depending on its resistance and the potential across the mains, and 10 lamps require 10 times as much as one lamp.

A Snapping Condenser.—Please explain the following phenomena observed in an induction coil: I have made an induction coil, using 1½ pounds No. 36 copper wire for secondary, with condenser with six quart Bunsen cells I get a two-inch spark in air; but what I don't know how to account for is the fact that when the primary circuit is broken there is caused a peculiar snapping sound in the condenser, and I think the snapping, too, is louder when the spark does not pass—for instance, there is too much air resistance. I have been very careful in making a condenser, soaking each sheet of paper in paraffin. The insulation seems to be good and it lengthens the spark considerably. 1. Should this snapping take place, and, if so, why? 2. The condenser has 50 feet of surface; is it large enough? 3. How many quart Bunsen cells would it be safe to use, there being over two pounds number 16 copper wire in the primary? 4. After having calculated how many calories are produced by a given current, temperature and resistance, how can I find how many degrees of heat are produced in the copper conductor, or any other conductor, by said calories?

F. F. C.

1. The snapping, if the sound produced is really a sharp snap, is probably due to discharge across the condenser. Some sheet of paper may be perforated or tinfoil may be too near the edge. Some times sounds are produced in a condenser simply because it is loose and a sort of crackling is produced among the loose leaves. As a rule, however, the former cause is most likely to account for what you observed. Careful re-insulation would probably stop it. 2. About the right size, if well insulated. 3. Your primary will probably carry half a dozen ampères without heating dangerously, depending somewhat on the shape in which it is wound and the length of time it is proposed to run it continuously. With quart Bunsen cells you will not get the best result by putting them all in series, but should arrange them so as to give the maximum current. Four in series and two abreast would probably be a good arrangement. 4. The amount of increase of temperature produced by a given resistance depends so much on the opportunities for cooling that no definite rule can be given. Carl Hering's "Principles of Dynamo-Electric Machines" gives the facts regarding coils such as are met with on field magnets, and for straight conductors Mr. Kennelly's recent articles in THE ELECTRICAL WORLD should be read.

Business Notices.

The Battery Cut-Out sold by the Electric Supply Company, of Syracuse, N. Y., 105 South Warren street, is cheap. Thoroughly tested, it is giving complete satisfaction. It automatically prevents the short-circuiting and damaging of gas lighting and other batteries. Send for circular.

OFFICE OF THE
SUPERINTENDENT LONG BRANCH ELECTRIC COMPANY,
LONG BRANCH, N. J., July 9, 1890.

Messrs. Chas. A. Schieren & Co., Ferry St., N. Y.:

GENTLEMEN; I have my station running now with six of your perforated electric belts, and am proud of them. Every one is as straight as a line, and any one coming into the station would think they were standing still. Yours truly,

A. ANDERSON, Supt.

Through Vestibuled and Colonist Sleepers Between Chicago and Tacoma, Wash., and Portland, Ore.—The Wisconsin Central and Northern Pacific lines run through Pullman vestibuled and colonist sleepers between Chicago and Tacoma, Wash., and Portland, Ore. The train known as the "Pacific Express" leaves the Grand Central Passenger Station, at the corner of Fifth avenue and Harrison street, at 10:45 P. M. daily. For tickets, berths in Pullman or colonist sleepers, etc., apply to Geo. K. Thompson, city passenger and ticket agent, 205 Clark street, or to F. J. Eddy, depot ticket agent, Grand Central Passenger Station, corner Fifth avenue and Harrison street, Chicago, Ill.

Office of INDIANA SANITARIUM,
Brookville, Ind.,
Dr. S. P. Stoddard, Prop'r.

May 2, 1890.

Jerome Kidder Mfg. Co., 820 Broadway, N. Y.

Please send by American Express one No.5 Tip Battery with sponge electrode, etc., completed. . . . The first of these Tip Batteries I bought of you I sent in 1873 to a friend in Omaha. The last was in 1883 or 1884, when I had an office at 177 West Forty-fifth street, New York. Since then I have been persuaded into Dry Cell, Chloride of Silver and all sorts of others, two of which are now in my house, but none have ever done for me so much work, and done it so well, as your No. 5. I enclose draft on New York.

Sincerely, S. P. STODDARD.